Okanogan/Similkameen Subbasin Summary

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This document has not yet been reviewed or approved by the Northwest Power Planning Council

Okanogan/Similkameen Subbasin Summary

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LIST OF ACRONYMS

ACCOE	Army Corps of Engineers
BLM	Bureau of Land Management
BMPs	Best Management Practices
BOD	Biological Oxygen Demand
BPA	Bonneville Power Association
CBFWA	Columbia Basin Fish and Wildlife Authority
CTCR	Confederated Tribes of the Colville Reservation
CDC	Center for Disease Control
cfs	cubic feet per second
DFO	Department of Fisheries and Oceans
DO	dissolved oxygen
EA	Environmental Assessment
EAP	Early Action Plan
ENTRIX	(not an antonym)
ERSPP	Columbia Basin Ecoprovince Review and Subbasin Planning Process
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
LFA	Limiting Factors Analysis
MELP	Ministry of Environment, Land, and Parks
MTCA	Model Toxics Control Act
NEPA	National Environmental Policy Act
NID	National Inventory of Dams
NOAA	National Oceanic and Atmospheric Association
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPPC	Northwest Power Planning Council
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Units
NWCO	Noxious Weed Control Office

LIST OF ACRONYMS (Continued)

OCD	Okanogan Conservation District
OCHD	Okanogan County Health District
OID	Okanogan Irrigation District
ONA	Okanogan Nations Alliance
ONF	Okanogan National Forest
OSS	On-site Sewage
OTID	Oroville Tonasket Irrigation District
OWSAC	Okanogan Watershed Stakeholders Advisory Committee
PNRBC	Pacific Northwest River Basins Commission
PSIAC	Pacific Southwest Interagency Committee
PST	Pacific Salmon Treaty
PUD	Public Utility District
RM	River Mile
SOSCP	South Okanagon-Silmilkameen Conservation Program
TAC	Technical Advisory Committee
TAG	Technical Advisory Group
TMDL	Total Maximum Daily Loads
TPN	Total Per Sulfate Nitrogen
U.S.	United States
USBIA	U.S. Bureau of Indian Affairs
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFS	United States Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
Working Group	Okanagon Basin Technical Working Group

LIST OF ACRONYMS (Continued)

WRIA	Water Resource Inventory Area
WSCC	Washington State Conservation Commission
WSDOE	Washington Department of Ecology
WSDOT	Washington Department of Transportation
WSOFM	Washington State Office of Fiscal Management

Executive Summary

In October of 2000, the Northwest Power Planning Council adopted a revised Fish and Wildlife Program for the Columbia River Basin. The new program is intended to be more comprehensive than, but complimentary to, regional efforts related to the Endangered Species Act, State-sponsored recovery and watershed planning and coordination efforts, and tribal recovery initiatives. The revised Program calls for an ecosystem-based approach for planning and implementing fish and wildlife recovery.

To accomplish this, the Program divides the Columbia Basin into ecological provinces that are further divided into individual subbasins. At the heart of the Program is the subbasin plan consisting of a comprehensive description of the basin general ecology including the identification of specific fish and wildlife needs. Future action strategies and project funding are to be based upon these identified needs. Subbasin *summaries* are an interim step to allow near-term implementation of the revised Fish and Wildlife Program until comprehensive subbasin *plans* can be completed. The information provided in this document satisfies the summary requirements for the Okanogan subbasin.

Accordingly, this report presents a compilation of known and existing data on anadromous fish and fish habitat for the United States and Canadian portions of the Okanogan River Watershed. Seventy-two subwatersheds were examined. The report also provides data and context for wildlife, land use, human population patterns, and overall resource management issues. Portions of the Similkameen watershed are included where additional anadromous fish distribution and access dictate. The Okanogan Subbasin Summary is the first report being generated from within the Columbia Cascade Ecoprovince. The Methow, Wenatchee, Lake Chelan, Entiat, and Upper (mainstem) Columbia subbasins comprise the remainder of this province.

Because this report represents the largest single subwatershed in the entire Columbia Basin, and is one of the only "transborder" watersheds, the document is lengthy. Great effort was expended to include all pertinent data and information focusing on the key ecological attributes and overall processes in the Okanogan. This was done while attempting to keep the document "manageable." While there will be differing opinions as to the success of this endeavor, the information presented has been scrutinized within the context of its general applicability for use in a focused and credible subbasin planning effort. The broad utility of this document will therefore be more useful in establishing interim actions as development of the final Subbasin Plan proceeds. This summary report will also provide guidance for developing regional priorities and processes.

The information and data presented in this document have been assembled and reviewed by a 22-member technical advisory committee and have been augmented with specific input from expert sources such as tribal staffs, state, provincial, and federal agency biologists, hydrologists, and local government staffs. This broad-based approach was necessary to compile the fundamental data and information in support of an ecosystem-based approach for fish, wildlife, and their diverse habitats.

This report also contains a final draft version of the Okanogan/Similkameen Limiting Factors Analysis (LFA). The LFA is sponsored by the Confederated Tribes of the

Colville Reservation (CTCR) and is being developed in conjunction with the Washington State Conservation Commission (WCC) as provided for in Engrossed Substitute House Bill 2496. The LFA technical effort is led by input from over 25 technical advisors representing state, federal, and local governments, and the public. The information contained within this report will be used for numerous applications, including providing critical habitat information for subbasin planning.

The report is organized according to the format developed by the Columbia Basin Fish and Wildlife Authority (CBFWA) and approved by the Northwest Power Planning Council. A summary of the major sections in this report includes:

- Fish and Wildlife Resources,
- Limiting Factors Analysis,
- Subbasin Habitat Reports,
- Recommended Actions,
- Goals, Objectives and Strategies,
- Existing Management,
- Proposed Actions by Management Agencies,
- Research, Monitoring and Evaluation Activities,
- Statements of Fish and Wildlife Needs,
- Subbasin Planning Maps (72 subbasins, including extent of anadromous ranges), and
- Pertinent Appendix Materials.

Taken together, these sections, and the detail contained within individual subsections, provide a focal point to be used by the reader and planner to accomplish the following general goals:

1. Establish actions, priorities, and guidance for development of specific project proposals for the intervening 3-year period between this report and final Subbasin Plan development;
2. Initiate an in-depth technical analysis of the information presented;
3. Identify major data gaps and assessment needs, and
4. Culminate these efforts into actions and final Subbasin Plan development.

Thus, in the near term, projects and actions will be determined by a review of the fish and wildlife needs and recommendations contained herein. The longer-term effort will require a more thorough and sophisticated approach employing tools such as the Ecosystem Diagnosis and Treatment Model and an expanded analysis of needs.

To sufficiently address the complex nature of the Okanogan Watershed, it was necessary to view this ecosystem as uniquely contiguous. This point cannot be overemphasized. International treaties and agreements, as well as language within the Northwest Power Act dictate a broad response to fish and wildlife recovery and protection in the Okanogan subbasin. Cooperation across the shared boarder and within the Okanogan watershed is required from both a legal and biological/ecological perspective.

Consequently, and, in order to facilitate continued transborder collaboration throughout the region, we have provided perspectives on how efforts between U.S. and Canadian management entities and stakeholders can be incorporated into the subbasin planning process. These features are unique to the Okanogan subbasin and contribute to the overall complexity, and utility, of this document and to the subbasin planning process.

This approach required that the subbasin summary effort incorporate a vast amount of information and data from the entire watershed, two-thirds of which is found within Canada. To retain the overall focus of the effort, and for the designated purposes and focus of this subbasin summary, we have limited some of the detail to the geographic extent of anadromous fish access. We recognize and acknowledge that Canadian and U.S. resident fish and wildlife issues may go beyond the detail provided in this report to date.

Major themes derived from the subbasin summary:

- The Okanogan watershed comprises one the of the largest geographic subbasins in the Columbia River Basin;
- The Factors influencing salmon survival and population status extend beyond the geographic boundaries of the Okanogan, and of the United States. Thus, coordination between basins, and in the Canadian portion of the watershed, is essential.
- There are significant needs and factors identified across all species, lands, and habitats that will require substantive actions in this basin;
- Near-term actions are needed in key subwatersheds;
- Land ownership throughout the watershed/subbasin is predominantly in private ownership;
- The basin is reasonably data rich in terms of geology, land use and climate, however, gaps in data for key environmental attributes, especially basin hydrology, land use impacts, and riparian and rangeland function, exist;
- Because of the geography of the basin, it is doubtful that salmon can be recovered, or overall ecological functions improved, without near-term actions, followed by long-term strategic planning;
- The use of artificial production strategies, such as supplementation, is an inextricable part of recovery planning;
- The effects of harvest in relation to this subbasin are poorly defined;
- Recovery efforts will have to be closely linked with passage improvements at all mainstem hydroelectric projects as well as with existing tributary and Okanogan river mainstem water withdrawal and diversions;
- All species of anadromous salmonids have experienced a long-term, and in most cases, severe decline in abundance, diversity and habitat productivity;
- Many resident fishes are also in decline, especially in the Canadian subbasins.
- Sockeye and steelhead represent the primary species for recovery and protection focus; spring chinook the best opportunity for restoration and reintroduction.
- Many issues are also applicable to summer/fall chinook salmon;
- Temperature issues predominate the factors influencing salmon survival in the mainstem Okanogan River;

- Resident and Wildlife related habitat issues are ill-defined, but impacts to ecological function are pervasive;
- Passage is a key component of the Canadian watershed limiting factors;
- The Okanogan Basin is fortunate to have a sophisticated and coordinated infrastructure focused on salmon recovery. The Upper Columbia Salmon Recovery Board provides one example that integrates many efforts;
- The Canadian portion of the watershed suffers from a lack of funding mechanisms, however, it is not lacking an overall impetus to address critical fish and wildlife issues;
- The subbasin planning process represents one of the best opportunities to support the Canadian tribes, citizenry, and governmental entities in initiating a host of new recovery options and funding strategies that will benefit the US portions of several fish and wildlife needs;
- The Okanogan basin has lacked detailed and coordinated assessment effort in the past. Thus, many new needs have been identified, and
- Goals, objectives, and strategies need, and will receive, continued refinement.

United States Okanogan/Similkameen Subbasin Summary

U.S. Okanogan/Silmilkammen Subbasin Description

General Description

Subbasin Location

The Okanogan River originates in British Columbia and flows south through a series of six large lakes before reaching the U.S. border (Figure 1) where it enters Washington State. The basin covers approximately 8,200 square miles, with 2,500 square miles in the United States. The eastern and western boundaries are steep, jagged, forested ridges at elevations ranging from 1,500 feet to over 5,000 feet above the basin floor. Tiffany Mountain is the highest peak in the drainage, at 8,242 feet above sea level.

The floodplain of the Okanogan River averages approximately one mile in width. The elevation of the valley floor ranges from 920 feet at the international boundary, to about 780 feet at Lake Pateros. Lake Osoyoos covers the northernmost 4 miles of the valley floor in the U.S., and extends several miles into Canada. Natural terraces, created mostly of glacially deposited gravel and sands, rise as much as 500 feet above the floodplain to the foot of, and between, the lateral ridges (WSDOE, 1995).

The river joins the Columbia River at river mile (RM) 533.5, between Chief Joseph and Wells dams, near the town of Brewster, Washington. The Okanogan River is the northernmost geologic dividing line between the Cascade and Rocky Mountain ranges.

Within Washington State the watershed is about 65 miles long, averages about 35 miles wide, and covers about 1.65 million acres. There are 32 subbasins within Washington (Table 1 and Figure 1). Several of these do not have surface flow into the Okanogan River. The Similkameen River, located primarily in Canada, contributes 75 percent of the flow to the Okanogan River.

The coastal and Cascade Mountains cast a rain shadow on the basin, giving it a dry climate. The interior portion of the Okanogan is considered true desert – it receives about 3.0 to 3.3 inches of rain annually. The open waters of the Okanogan's finger lakes moderate local temperatures, however, cooling the air in summer and warming it in winter.

The basin is home to over two dozen species of plants and animals that are currently listed in the U.S. and Canada as nationally Threatened, Endangered, or Vulnerable. A full one-third of *all* Red-listed species in British Columbia reside in the Okanogan, and the National Marine Fisheries Service has concluded that the upper Columbia, where spring chinook and steelhead are listed as endangered, is the first priority for recovery planning efforts in the Columbia Basin. Additionally, the Okanogan supports one of only two viable populations of sockeye salmon left in the entire Columbia Basin.

The Okanogan Basin is an important ecological corridor for migratory megafauna as well. Species such as mule deer utilize the north-south corridor that connects the dry landscapes of British Columbia's interior with the grasslands to the south. In addition to salmon and megafauna this corridor is a crucial part of the flight path for many species of birds during annual migrations between summer and winter ranges.

Climate

Cold, snowy winters and hot, dry summers characterize the semi-arid climate of the Okanogan River Watershed. The climate is influenced by the barrier to marine air that the Cascade Mountain Range provides, as well as by the mountain and valley formations of the region. Precipitation in the watershed ranges from more than 40 inches in the western mountain region to approximately 8 inches at the confluence of the Okanogan and Columbia Rivers. Precipitation in the main river valley averages approximately 12 inches annually (NOAA, 1994). The Okanogan Highlands, in the easternmost part of the basin, receives an average of 25-35 inches per year. About 50 to 75 percent of annual precipitation falls as snow during the winter months. Okanogan County's forestlands receive approximately 75 percent of the total annual precipitation (Gullidge, 1977). July, August, and September are the driest months.

Mean annual temperature for the Okanogan Watershed is 49° F. The average temperature for January is 21° F and the July average is 73° F. Temperatures and weather conditions vary widely by elevation. Wind velocities throughout the region are calm to moderate, and winds generally originate from the north or south. Thunderstorms occur occasionally in the watershed during late spring and early summer. Summer months have approximately 5 cloudy days per month, and winter has about 20 cloudy days per month. On average, there are 150 frost-free days each year in the main Okanogan River Valley, and about 75 frost-free days in the surrounding uplands (NOAA, 1994).

Geology

The bedrock geology of the basin is composed primarily of granitic, andesitic, metamorphosed sedimentary and basaltic rocks. These rocks form a complex arrangement of geologic terrains that are highly fractured, folded, and faulted.

During the last large-scale glaciation, the entire Okanogan drainage was covered by the Okanogan Lobe of the Cordilleran ice sheet. As the glacier melted, it deposited sequences of silt, sand, gravel, and cobbles. These sequences of unconsolidated materials are present as valley fill and form the walls of terraces. More recently, rivers have scoured the bedrock and glacial deposits and redeposited them as additional sand and gravel terraces and plains, and volcanic eruptions have deposited ash.

Soils

Most of the soils in the valley derived from volcanic ash and glaciation within the last 10,000 years. In that time, there has been accumulation of organic matter and translocation of carbonates, iron, aluminum, and small amounts of clay. Well logs and soil reports indicate that valley fill and terrace deposits may be more than 500 feet thick in areas (WSDOE, 1995). There are ash layers from the geologically recent eruptions of Mt. Mazama, Glacier Peak, and Mt. St. Helens. Depth and degree of mixing of the ash mantle varies with aspect and topography.

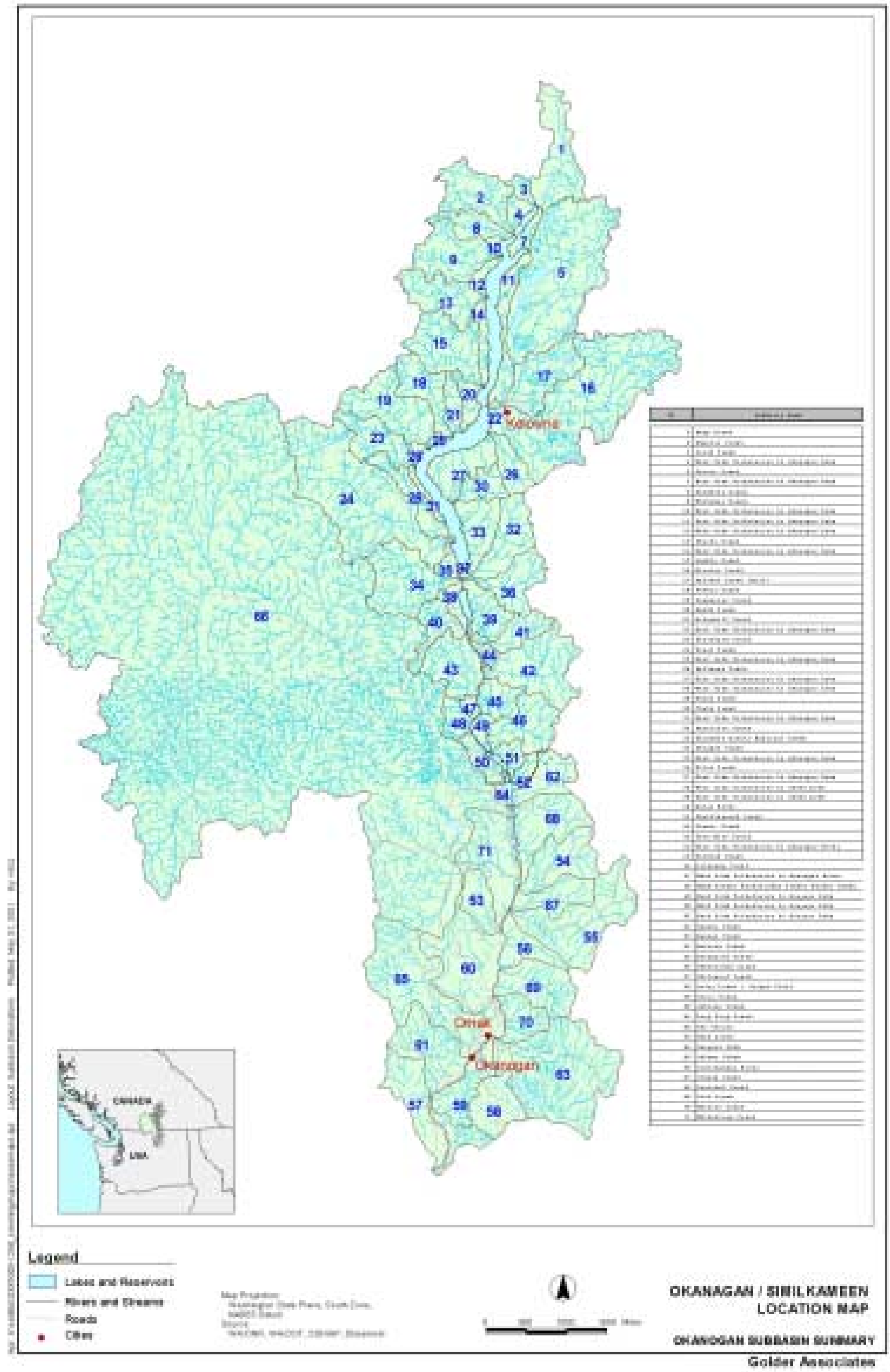


Figure 1: Site Map.

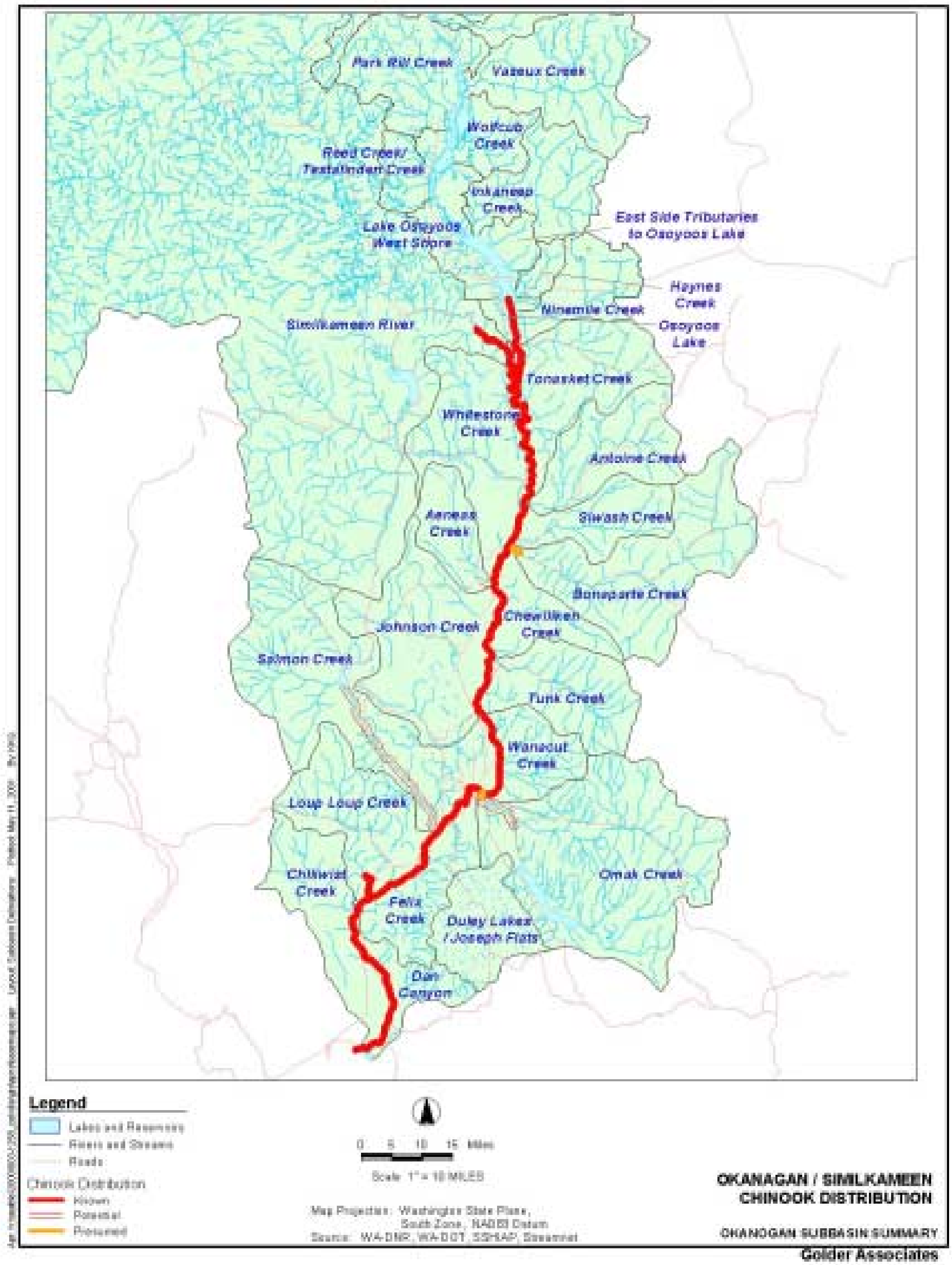


Figure 2: Chinook Distribution.

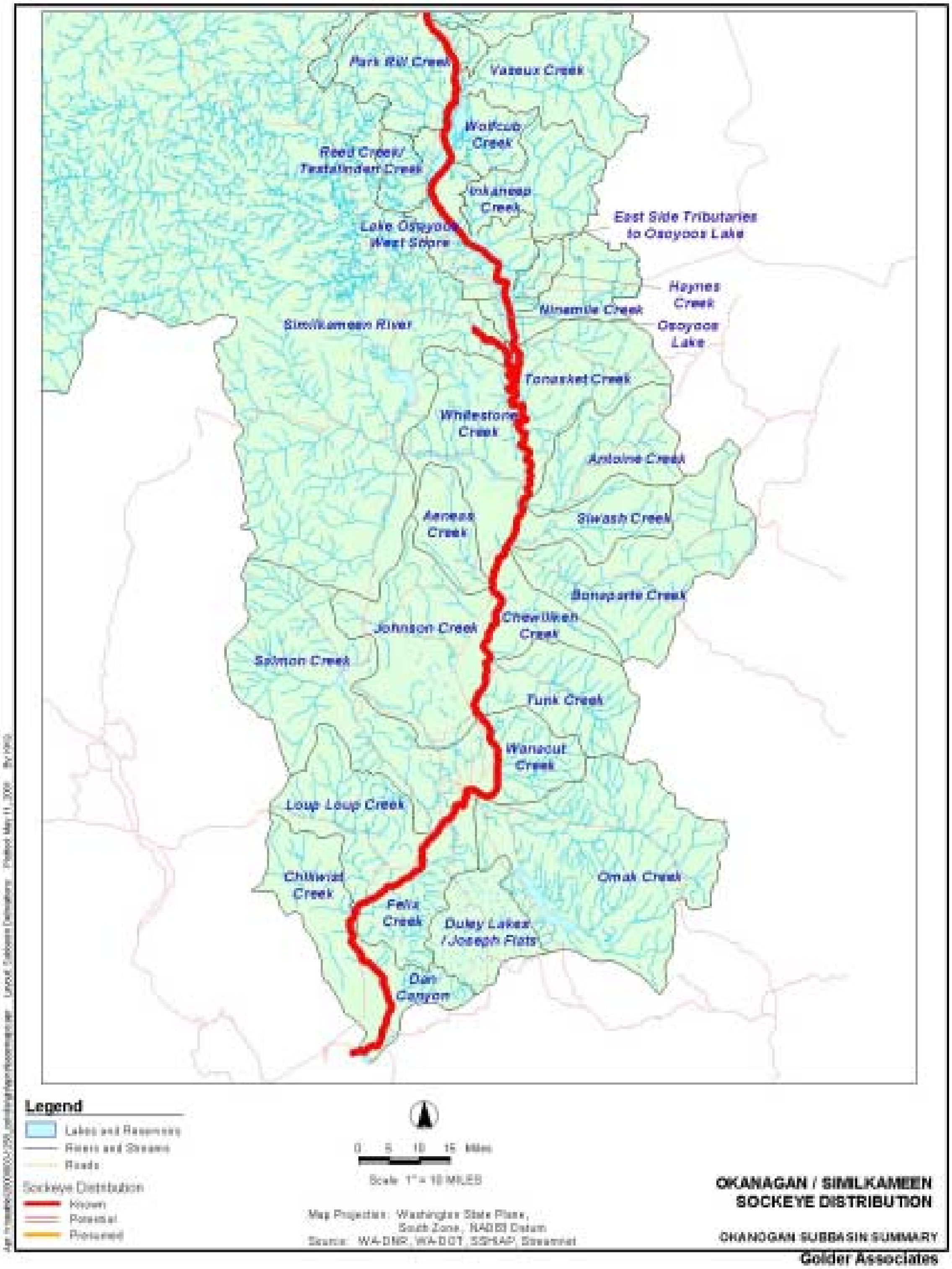


Figure 3: Sockeye Distribution

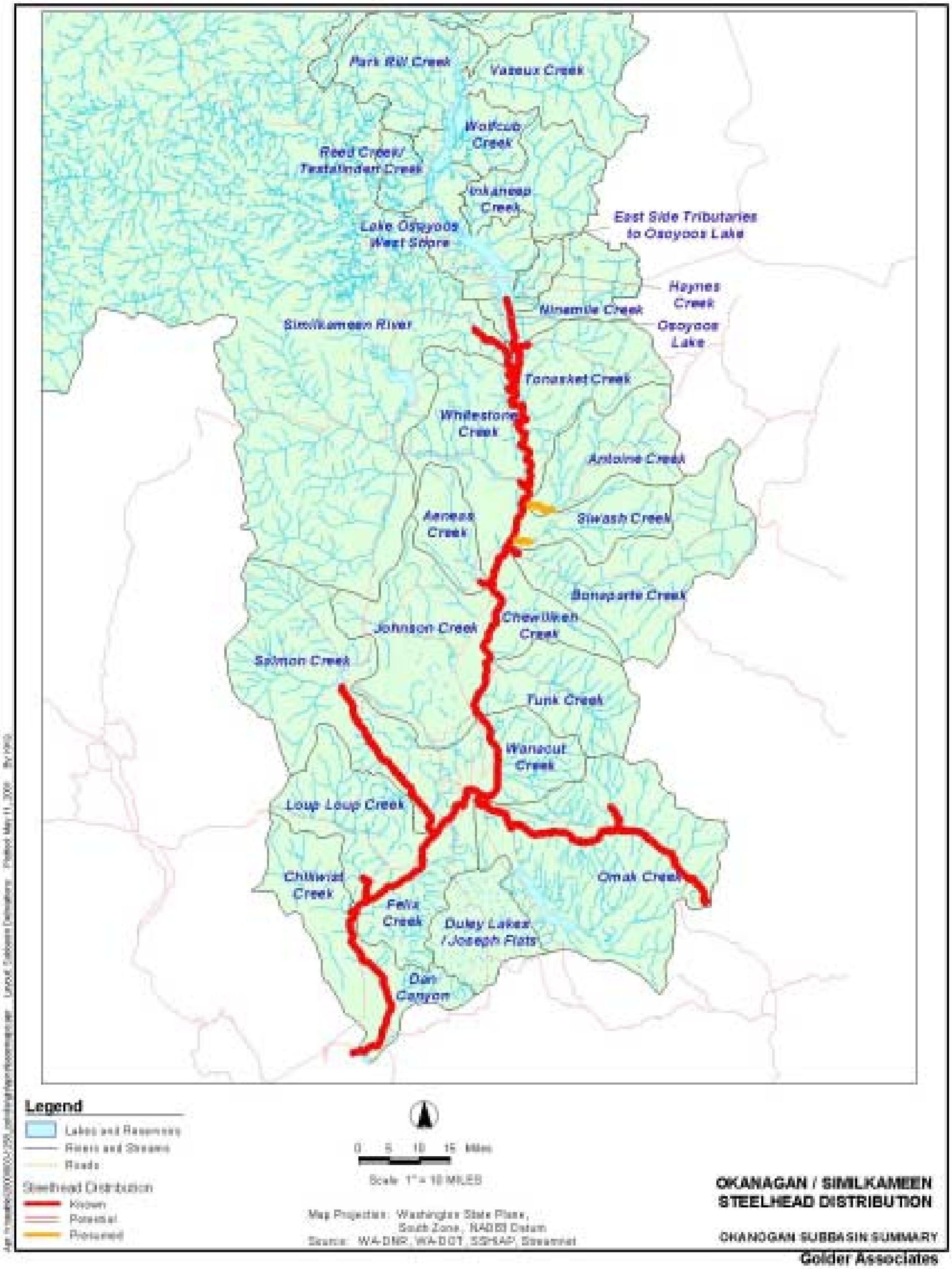


Figure 4: Steelhead Trout Distribution.

Table 1: Selected Subbasins of the Okanogan/Similkameen Watersheds.

U.S. Subbasins	U.S. Subbasins (cont'd.)
Aeneas Creek	Omak Creek
Antoine Creek	Osoyoos Lake
Bonaparte Creek	Salmon Creek
Chewiliken Creek	Silmilkameen River
Chiliwist Creek	Siwash Creek
Dudley Lakes/Joseph Flats	Tonasket Creek
Felix Creek	Tunk Creek
Johnson Creek	Wanacut Creek
Loup Loup Creek	Whitestone Creek
Nine Mile Creek	
Canadian Subbasins	**Canadian Subbasins (cont'd.)**
Bellevue Creek	Ninemile Creek (U.S./Canada)
Deep Creek	Osoyoos Lake (U.S./Canada)
Ellis Creek	Park Riff Creek
Enear Creek	Peachland Creek
Equesis Creek	Penticton Creek
Haynes Creek	Powers Creek
Irish Creek	Okanogan Lake East Shore
Irrigation Creek/Vastux Lake	Skaha Creek
Keefe Creek	Shingle Creek
Kelowna Creek (Mill)	Shuttleworth Creek
Lake Osoyoos/West Shore	Shorts Creek
Lamby Creek	Similkameen River (US/Canada)
MacDonald Creek	Trepainer Creek
Madeline Lake	Trout Creek
Maron River	Unnamed #1 (north)
Matheson Creek	Unnamed #2 (south)
McLean Creek	Vaseux Creek
Mission Creek	Vernon Creek/Kalamalka Lake
Naramata Creek/Lake	Whiteman Creek
Nashwito Creek	Wolfcub Creek
Newport Creek	

The Okanogan valley is narrow and steep-walled and many of the soils are loose. This condition contributes to streambank instability and sediment delivery. The most erosive soils along the Okanogan River are the Colville silt loams and Bosel fine sandy loams.

The soils of the watershed have been placed into three major groups:

- Soils of steep and very steep mountainous lands. Soils are slightly acid to extremely acid, sandy loam to silt loam soils formed in volcanic ash, glacial materials, and weathered granite, schist, limestone, shale, and gneiss. These soils are predominantly forested.

- Soils of the nearly level to strongly sloping valleys, terraces, plateaus, and till plains. These soils are moderately deep and deep loam, silt loam, and sandy loam formed in glacial outwash, alluvium, ash, and pumice. Some bottomland soils are sandy loam formed in glacial outwash, alluvium and lake sediments. Also included in this group are moderately deep and deep loam soils formed in glacial till with some wind-laid silts, ash, and pumice overlay. These soils are mainly used for forage and crop production; some areas also have shrub and forest cover.
- Soils of gently sloping to steep uplands. These are deep silt loam and loam soils formed in volcanic ash and glacial till and underlain by granite, basalt, andesite, and limestone. They are primarily in grassland cover (Pacific Northwest River Basins Commission, 1977).

For a map of soil types, Figure 5.

Vegetation

There are 71 species of state and federally listed plants in Okanogan County. (this list is available at http://www.wa.gov/dnr/htdocs/fr/nhp/refdesk/lists/plantsxco/okanogan.html). These plants are vitally important to the quality of the fish and wildlife habitat of the region. Virtually every plant in the region is important to the CTCR and tribal membership for their cultural, historic, and subsistence value. The CTCR do plant inventories of the region. Many species are declining due to land use practices.

Forest

Forestland comprises approximately 47 percent of the Okanogan River Basin. Dominant forest species include ponderosa pine, Douglas-fir, lodgepole pine, Englemann spruce, western larch, subalpine fir, and aspen. Whitebark pine and subalpine larch occupy alpine settings. Dominant riparian species include black cottonwood, water birch, and white and thinleaf alder (Arno, 1977), but riparian forests and shrub steppe have been virtually eliminated in the basin. Table 2 summarizes the forest types in the Okanogan Basin that would be present under natural conditions.

Prior to European settlement, frequent fires in the mid elevations, (2000 to 4500 ft) created open stands of predominantly mature, fire-resistant Ponderosa pine, with a smaller larch component above 3,000 feet. Unpublished preliminary data of forest reconstruction plots in North Central Washington indicate 12 to 20 percent canopy closure at these elevations. In the 1900s, fire suppression led to a dramatic increase in seedling survival, creating stands with 100 percent canopy closure. Shade tolerant, fire sensitive Douglas-fir is now favored over fire-tolerant, but shade-intolerant pine and larch.

Harvest of large trees has also contributed to the current condition of dense stands dominated by small, suppressed Douglas-fir that is prone to insect infestation, disease, and catastrophic fire. An extensive road system in the forest has increased the sediment delivery to the stream channels. Sediment-laden runoff is exacerbated by the predominance of loose soil types that have high erosion potential. The road system is also a major source of weed transport, and weed infestations are present throughout the basin.

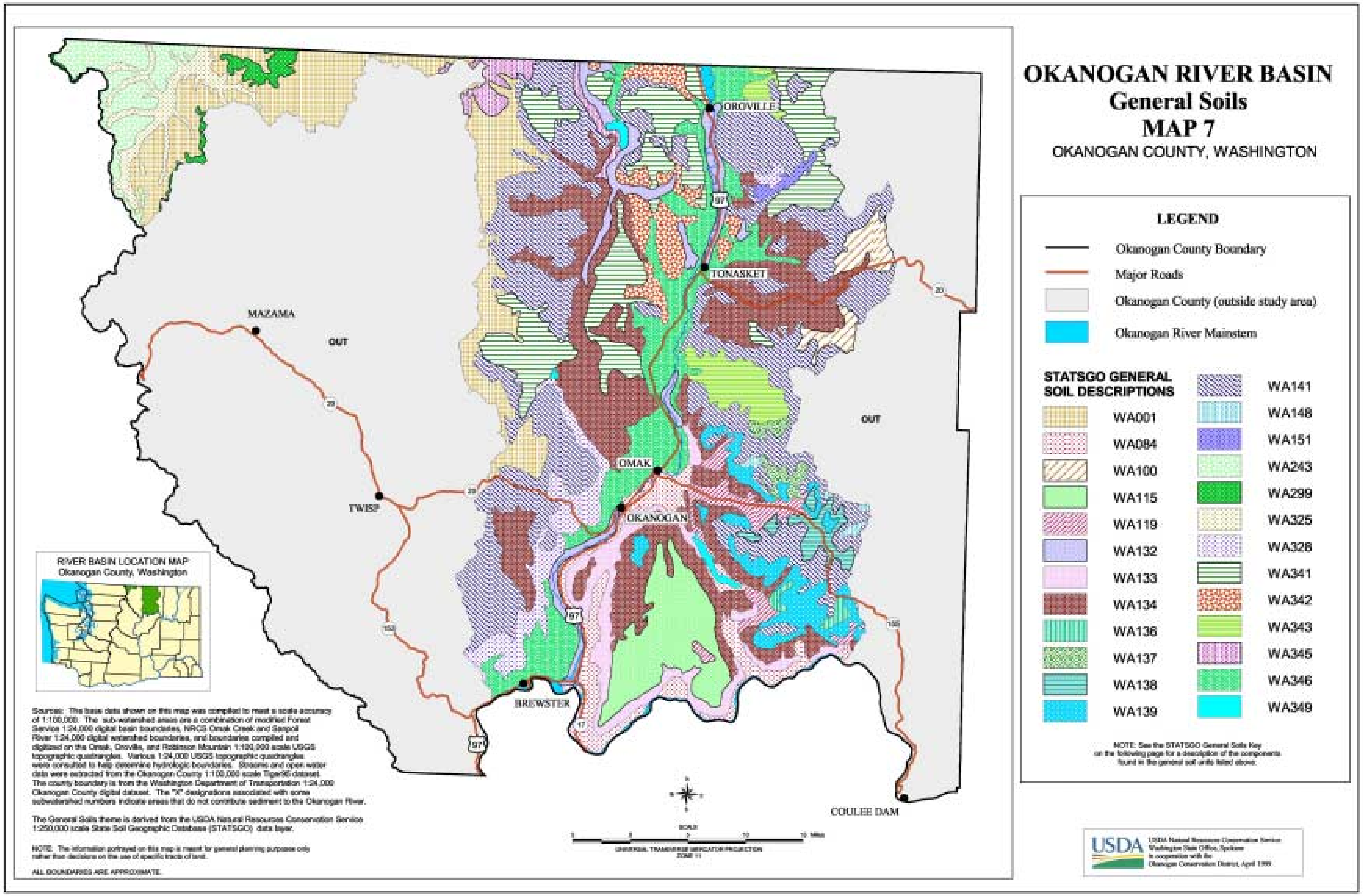


Figure 5: Soils Map for the Okanogan Basin.

Shrub Steppe

Shrub-steppe habitat was originally a major component of the landscape in the Okanogan Basin, extending from the outer edge of the floodplain to the beginning of the lower elevation forest, at roughly 2500-foot elevation. Native shrub-steppe habitat is dominated by shrubs and perennial bunch grasses, with a microbiotic crust of lichens and mosses on the soil surface. Sagebrush was the dominant shrub; bitterbrush was also an important component (Oregon-Washington Partners in Flight, 2000).

Native shrub-steppe communities have been diminished in both extent and condition as a result of overgrazing by livestock, invasion of non-native plants, agricultural conversion, and wildfire suppression. Most extant shrub-steppe may appear to be in a natural condition, but it is actually a considerably altered ecosystem, compositionally and functionally different than pre-European settlement conditions (Partners in Flight, 2000).

Riparian/Floodplain

The Okanogan River valley is broad and flat. Given the topography and geology, the river probably once meandered across the valley, and riparian habitat formed an extensive mosaic of diverse species. It was dominated by some combination of grass-forbs, shrub thickets, and mature forests with tall, deciduous trees. Common shrubs included willows, red-osier dogwood, hackberry, mountain alder, Wood’s rose, snowberry, and currant. Trees included cottonwood, aspen, and water birch (Oregon-Washington Partners in Flight, 2000).

Since European settlement, the river has been channelized from the mouth to beyond the U.S. border. State and county highways parallel the river at close proximity for its entire length in the U.S., except for a reach from Riverside to Janis, Washington. This is the only largely undeveloped reach in the U.S. along the Okanogan River floodplain. Agriculture, primarily orchards, livestock feed, and wheat, dominates the valley bottom. There are also several population centers and municipalities along the river and the lower reaches of the tributaries. Riparian vegetation such as cottonwood, spruce, alder and a dense shrub layer are virtually nonexistent. Agriculture, residences, and associated roads contribute chemical contaminants and sediments to the streams and rivers.

Hydrology

The hydrology of the Okanogan River Watershed is characterized by high spring run-off and low flows occurring from late summer through winter. Peak flows coincide with spring rains and melting snowpack. Low flows coincide with minimal summer precipitation, compounded by the reduction of mountain snowpack. Irrigation diversions in the lower valley also contribute to summer low flows.

Table 2: Forests of the Okanogan Basin

Forest Type (i) = shade intolerant * = dominant species	**Dominant Disturbances**	**Location and Habitat Type**	**Characteristic Plant Species**	**Characteristic Wildlife Species**
Low-elevation, dry *Ponderosa pine zone* * ponderosa pine (i) Douglas-fir	Frequent, low-intensity ground fires are typical but not universal (mixed- and high-intensity fires uncommonly occur). Localized outbreaks of western pine beetle in stressed ponderosa pine. Other pathogens of ponderosa pine include *Armillaria* root disease and western dwarf mistletoe.	Located between 1,500' and ~3,000' elevation, higher on s-facing slopes and ridgetops. These forests are generally open and park-like due to frequent ground fires, dominated by large/old pines. Tree regeneration is in small, scattered pockets, including both ponderosa pine and Douglas-fir.	Shrubs: antelope bitter-brush, big sagebrush, snowbrush ceanothus, kinnikinnick, wax currant, serviceberry Forbs: bluebunch wheatgrass, Idaho fescue, arrowleaf balsamroot, Lyall's mariposa lily	Birds: white-headed woodpecker, pygmy nuthatch, gray flycatcher, flammulated owl Mammals: yellow pine chipmunk, silver-haired bat, sagebrush vole, mule deer (winter range)
Mid-elevation, moist *mixed conifer zone* * Douglas-fir ponderosa pine (i) lodgepole pine (i) western larch (i) west/white pine (i) grand fir	Mixed severity fires are typical, w/fire intensity and size determined by complex interaction of weather, fuels, and terrain. Species-specific pathogens (e.g., root diseases, bark beetles, dwarf mistletoe) can be important in localized areas.	Located between 2,000' and 5,500' elevation, usually mid-slope locations on all aspects and topographic positions. Variable stand structure, ranging from relatively open and park-like to dense, multi-storied. Trees in understory are shade-tolerant species.	Shrubs: boxwood, Oregon grape, wood rose, shinyleaf spiraea, common snowberry Forbs: heartleaf arnica, coltsfoot, broadleaf lupine, western sweetroot, showy aster, little sunflower	Birds: northern goshawk, pileated woodpecker, Townsend's warbler, western tanager Mammals: Pacific fisher, porcupine, red squirrel, pygmy shrew

Forest Type (i) = shade intolerant * = dominant species	**Dominant Disturbances**	**Location and Habitat Type**	**Characteristic Plant Species**	**Characteristic Wildlife Species**
High-elevation, wet *Subalpine fir zone* * subalpine fir * Engelmann spruce * lodgepole pine (i) subalpine larch (i) Pacific silver fir mtn. hemlock whitebark pine (i) Rocky Mtn. juniper Sitka alder (i)	Infrequent, high-intensity fires are typical in dense, continuous forests; intensity is reduced on open, rocky sites. Snow avalanches occur in steep terrain, widespread outbreaks of mountain pine beetle occur in older, stressed stands of lodgepole pine.	Between 5,000' and 8,500' elevation, on upper slope positions and in cold air drainages. Growth is slow in these forests and nutrients may be limiting. Standing dead and downed trees may persist for a long time because cool temperatures slow decomposition rates.	Shrubs: mountain huckleberry, Cascade azalea, rusty menziesia, mountain ash Forbs: Sitka valerian, mountain heather, partridgefoot, pasqueflower, one-sided wintergreen	Birds: Clark's nutcracker, gray jay, hermit thrush, spruce grouse Mammals: lynx, pine marten, wolverine, snowshoe hare (in winter), moose
Riparian * black cottonwood * quaking aspen * willow spp. mountain alder Douglas maple western red cedar Pacific yew water birch black hawthorne	Riparian areas most often burn at low intensity, due to their valley bottom position and abundant moisture. Occasional moderate to high intensity fires do occur, with the risk increasing with decreasing area of riparian forest and increasing elevation. Floods are also important disturbance events, rearranging the stream channel and setting back forest development. All of these disturbances generate large woody debris, which plays a critical role in the aquatic ecosystem.	Stream-side locations in valley bottoms at all elevations. Low-elevation, bottomland locations have the most extensive, well-developed forests. Species composition of deciduous broadleaf trees and shrubs changes gradually with elevation, stream gradient, and moisture availability. Species diversity of both plants and animals is extremely high in these forests. Structural complexity generally increases with increasing time following a major disturbance event.	Shrubs: redosier dogwood, prickly currant, twinberry honeysuckle, thimbleberry Herbs: horsetail, bog orchid, tiger lily, false hellebore, baneberry, monkshood, starry Solomon's seal, fairy bells	Birds: American dipper, belted kingfisher, yellow warbler, willow flycatcher, red-eyed vireo, veery Mammals: mink, Pacific water shrew, beaver, numerous bat spp. Amphibians: tailed frog, Columbian spotted frog

Source: *Forests of the Methow Valley*, Evan Frost, 1999.

The hydrologic function of the watershed has changed over the last century in response to human activity. The Okanogan River has been channelized for its entire length in the U.S., and is no longer connected to its floodplain. Forest and range management practices have altered forest species composition, age class mix, and soil conditions.

Formerly, Douglas-fir was confined to wet areas or areas where topography limited fire intensity. Frequent low-intensity fires favored survival of mature pine and larch while increasing mortality rates for seedlings, younger trees, and Douglas-fir. This condition maximizes interception loss, and minimizes the snowpack on the ground (OWSAC, 2000).

Streamflow

The average annual flow for the Okanogan River, measured at Ellisforde, is 3200 cubic feet per second (cfs). About 75 percent of the flow comes from the Similkameen River, located primarily in Canada. The gradient on the U.S. portion of the mainstem Okanogan averages about 0.04 percent. The first 17 miles of the river are within the backwater of Wells Dam (NMFS, 2000).

Stream flow in the U.S. portion of the Okanogan River is controlled by a series of 13 dams in British Columbia, and the Zosel Dam on Osoyoos Lake in Washington. Water releases to meet fishery needs are negotiated yearly by a consortium of fisheries and irrigation managers from both Canada and the U.S.

The USGS has been recording flows in the Okanogan Basin continuously since 1911. Table 3 summarizes USGS flow data for the basin.

Table 3: USGS Flow Records for Okanogan and Similkameen Rivers, 1911 – 1996 (USGS, 1995).

Station #	**Location**	**Year Started**	**Average Flow (cfs)**	**High Flow (cfs)**	**Low Flow (cfs)**
12438700	Oliver, B.C.	1944	639	3,740	55.9
12439500	Oroville, WA	1942	676	3,730	-2,270*
12445000	Tonasket, WA	1929	2,940	44,700	126
12447200	Malott, WA	1958	3,063	45,600	288 **
12442500	Nighthawk (Similk. R.), WA	1911	2,289	45,800	65

**During high flows, backflow from the Similkameen River results in negative flow values on the Okanogan at this station.*
***This record was observed.*

The WSDOE established base flows for the Okanogan and Similkameen rivers in 1976 (Table 4). Data are based on measurements made at the USGS Tonasket gaging station and snow survey data collected by NRCS. This table is a simplified version of the flow standards set in the Washington Administrative Code. At the time these base flows were established, WSDOE ruled that no further appropriations of surface water shall be made from the Okanogan River and its tributaries if they would conflict with these base flows (NOAA, 2000).

Table 4: Base Flows (cfs) for the Okanogan River, as Set by WSDOE in 1976 (NMFS, 1998).

Reach	April*	May*	June*	July*	August*	September*	October*
Lower Okanogan RM 17.4 - 51	1120 1,250	1,400 4,000	4,000 4,000	2,400 1,400	1,050 800	800 800	940 1,100
Middle Okanogan RM 51 - 70	910 1,070	1,200 3,800	3,800 3,800	2,150 1,200	840 600	600 600	730 900
Upper Okanogan RM 70 - 77.6	330 340	350 500	500 500	420 350	320 300	300 300	330 370
Similkameen RM 0 - 27.3 (Canadian border)	510 640	800 3,000	3,000 3,000	1,650 900	590 400	400 400	450 500

*The top value is for the first half of the month, the bottom value for the latter half of the month.

Groundwater

There have been several groundwater studies conducted in the watershed, but little is known about the deep, hard-rock aquifers. The shallow aquifers are characterized in the following quotation from a WSDOE report:

> Alluvial and glacial sedimentary deposits, ranging from a few feet to several hundred feet thick, contain the main volume of groundwater in the basin, with sand and gravel layers constituting the principal water-bearing zones. Most of the sedimentary deposits occur in or adjacent to major valleys and are underlain by rather impermeable bedrock which consists principally of granitic and various metamorphic rocks; limestone, dolomite, and basalt form the bedrock in small areas. Generally, the bedrock establishes the floor of the groundwater reservoir, although cracks in the bedrock below the water table become filled with water, and limestone, dolomite, and basalt formations yield small quantities of water to springs and wells.
>
> In some places, the sedimentary deposits are thick and consist almost entirely of sand and gravel containing large quantities of groundwater. In other cases, the deposits hold little water, being thin or consisting mostly of clay or poorly permeable glacial till. (WSDOE, 1974)

Groundwater in the Okanogan tends to be more mineralized than surface water, and the chemical composition varies more. There have been occurrences of excessive iron and sulfates, but generally the water is usable for most purposes. Groundwater in the basin is typically hard to very hard. Ground water temperature ranges from 11^0C to 16^0C; the shallower zones tend to produce cooler water. Nitrate levels in tested wells ranged from 0.3 to 4.9 parts per million (Walters, 1974).

The shallow aquifers tend to be high in sediments, indicating that it is fairly susceptible to pollution during ground-disturbing activities.

The coarse soils in the basin create hydraulic continuity between the ground and surface waters. Most municipal water is supplied from wells that penetrate the groundwater aquifers. Supplies are probably adequate, given the current demand, but groundwater tables are dropping in some areas.

Population

The population of Okanogan County in 1998 was approximately 38,400, according to the Washington State Office of Financial Management (WOFM, 1999). Population figures have never been collected specifically for the Okanogan River Watershed. Table 5 displays recent changes in population in cities in the basin.

Table 5: Okanogan Subbasin City Populations and Growth Rates 1990-1998. (OFM, 1998)

City	1990	1998	% Increase
Brewster	1,633	2,050	25.5%
Conconully	174	205	17.8%
Okanogan	2,370	2,415	1.9%
Omak	4,117	4,435	7.7%
Oroville	1,505	1,595	5.9%
Pateros	570	595	4.3%
Riverside	223	365	63.7%
Tonasket	900	995	10.6%

Land Ownership

Land within the Okanogan River Basin is split almost evenly among public, private, and Tribal ownership (Figure 6 and Table 6). Colville tribal lands include both private and Tribal ownership. The diverse ownership complicates resource management in the basin.

The USFS manages 58 percent of commercial forests on public lands, the Bureau of Indian Affairs manages 24 percent, and the WDNR manages 16 percent. Most privately owned commercial forests are small blocks. Conversion of privately owned timber areas into other uses, such as residential subdivisions, is a trend, but not on the large scale that it is further south, in Wenatchee and Entiat (NMFS, 1998). During a recent four-year period (1994-1997), approximately 11,000 acres of forestland were subdivided (OWSAC, 2000).

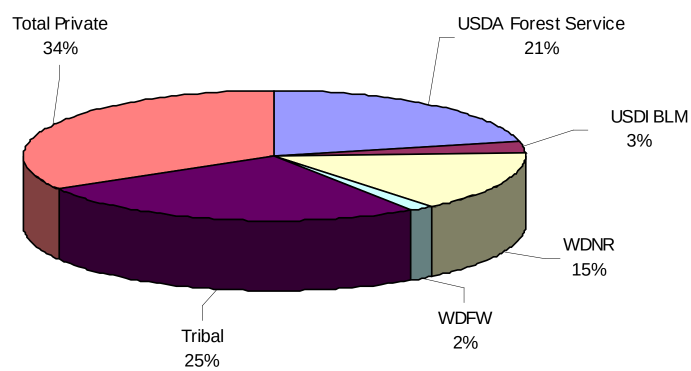


Figure 6: Major Landowners in the Okanogan Basin.

Land Use

History

Humans have been living in the Okanogan Basin for at least 7,000 years (Wilson, 1990). Before European settlement, native tribes lived in small, autonomous bands or villages (Honey, 1979). Most of the natives of the region spoke Salish, but there were seven languages in the Okanogan area alone (Wilson, 1990).

The Okanagan Tribe

The word "Okanogan" is derived from a Salish word which refers to the place on the Okanogan River which marks the furthest ascent of salmon up the river. Okanogan territory stretched from where the Okanogan River flows into the Columbia in the south, to beyond Lake Okanogan in the north. The tribe's territory stretched east from the crest of the Cascades for one hundred miles. Okanogans did not recognize the United States/Canadian border as a demarcation dividing the tribe, but the boundary has created somewhat different lifestyles for those north and south of the border.

At least five bands of Okanogans lived south of the United States/Canadian border in at least twelve villages. Okanogans hunted, fished and gathered throughout that territory. There were salmon traps at locations near Oroville, Monse, Malott, and Omak. Other fish were caught in various locations inland from the Okanogan River. Bear, deer, mountain goats, rabbits and other small game, ducks, geese and grouse were hunted throughout Okanogan territory. Foods gathered included service berries, thorn berries, huckleberries, blueberries, raspberries, strawberries, Oregon Grape. Bitterroot was also dug as was some Camas. Various native medicines were also gathered. Soapstone, dyes and paints were also collected at locations west of the Okanogan River. The stretch of Okanogan River controlled by the Okanogan also constituted a portion of an important trade route, with the mouth of the Okanogan being an especially important trading location.

The Okanogan bands were not parties to any treaty with the United States, and remained relatively isolated from Whites until the Moses Columbia Reservation was established in 1879-80. In 1886 the reservation was opened to non-Indian settlement, but a few Okanogans received allotments west of the Okanogan River and continued to live there. Most Okanogans moved onto the Colville Reservation and became one of the Confederated Colville Tribes. Today there are still a few allotments west of the Columbia River, but most people continue to live on the Colville Reservation. Tribal members continue to utilize their traditional food resources throughout their territory, fishing for salmon, digging camas, and gathering berries within their ancient territory (Hart, 2001).

Winter housing sites, located on southern aspects close to water, likely received heavy use, as did the summer housing sites at the fishing grounds. However, these areas were not occupied year around and were likely quite small. In the spring, small family groups dispersed to gather roots (Ray, 1933). Due to the dispersed activity and the small group size, root gathering had little to no effect on water quality in the watershed.

Table 6: Okanogan Subbasin Land Ownership (U.S. Only) (NRCS, 2000).

Ownership	Agency	Acreage
Federal	USDA Forest Service	357,000
	USDI BLM	48,000
	USDI FWS	2,750
	USDI Dept of Defense	375
	Total Federal Lands	**408,125**
Washington State	WDNR	245,000
	WDFW	29,873
	Department of Parks & Recreation	600
	Total State Lands	**275,473**
Other Public Lands	Okanogan County	300
	Municipal	2,900
Total Public Lands		**686,798**
	Tribal	422,000
	Private	559,000
Total Land Area		**1,667,798**

Trappers and traders moved to the area in the early to mid 1800s. Orcharding gradually became the mainstay of the local economy; growth was slow due to limited transportation and the lack of irrigation (Wilson, 1990).

Gold mining brought a major influx of people to the valley in the late 1800s. Many boom towns sprang up. The most famous town was Ruby, which became the first county seat of Okanogan County in 1888. The county seat was moved eleven months later to Salmon City (now named Conconully). Soon afterwards the gold diminished, the miners moved away, and the boom towns declined in size and distinction. Mining in the Fraser River basin in British Columbia spurred large cattle drives up the Okanogan River Valley. The British customs station at Osoyoos collected duty on 22,256 head of beef cattle between 1859 and 1870. It is likely that as many cattle or more escaped the collector's attention (Wilson, 1990). This activity suggests over-grazing occurred along the river's floodplains (Wissmar et al., 1994).

The mining economy was replaced by dry land farming and ranching. During high spring flows, paddle-wheel riverboats traveled up the Okanogan River to the town of Riverside to offload goods and new settlers. In 1914, the Great Northern Railroad came to the basin, virtually replacing the paddle-wheelers. Following in the footsteps of the railroad was the extensive expansion of irrigation systems throughout the valley. With the relatively fast and reliable railroad service to the area, farmers were able to convert more and more land into agricultural production, most notably orchards. Better transportation and a solid economic base allowed the communities to become more settled and permanent.

Current Conditions

Land use in the Okanogan Basin includes timber, rangeland, agriculture, and residential.

Forestry and range are by the far the major uses of land in the Okanogan Basin, followed by croplands (Table 7 and Figure 7). Most of the landscape, from the riparian areas to the upper elevation forests, have been used extensively for agriculture and resource extraction. The valley bottom is dominated by agriculture, primarily orchards and livestock feed. The benches are dominated by livestock grazing, and the lower to mid-upper elevation forests have been harvested for timber and used for livestock grazing. The Okanogan Basin contains six state wildlife areas, a natural preserve in the DNR's Loomis Forest, and a portion of the USFS's Pasayten Wilderness.

Table 7: Approximate Total Acreage of Land Use Types in the Okanogan Basin (U.S. Only)

Land Use	Acreage (approx.)
Forest	787,070
Range	754,996
Cropland	101,930
Urban	5,737
Other	18,065
Total Land Area	1,667,798

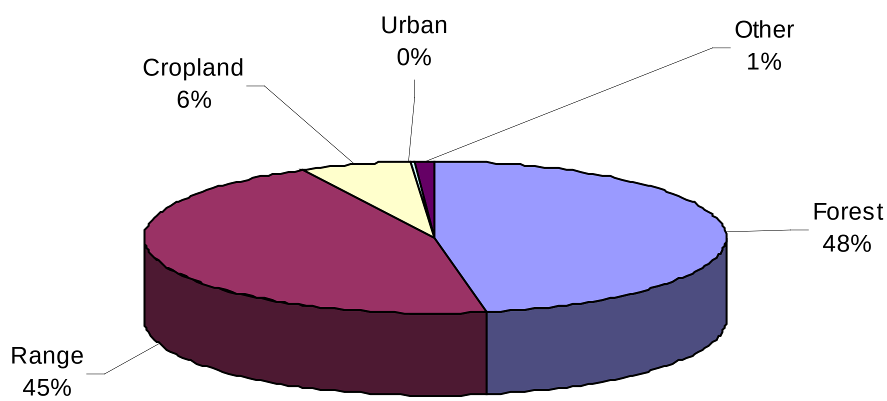


Figure 7: Land Use Types in the Okanogan Basin (U.S. Only) (NRCS, 2000)

Timber

Most of the forested land is publicly owned, and most of it is managed for timber. The major timber-producing areas in the basin are Toats Coulee, managed by the USFS, and the Loomis Forest, managed by WDNR. Forest productivity in the basin is relatively low due to the arid climate, the short growing season at high elevations, and steep, rocky terrain (NMFS, 1998).

Range

Livestock production is a major part of the economic base in the county. There are 754,996 acres of rangeland in the Okanogan Subbasin, owned and managed by USFS, BLM, DNR, CTCR, and private owners. Cattle are grazed on forested lands as well as grass lands. Much of the Okanogan floodplain is used for forage crops and livestock wintering grounds (PNRBC, 1977). The Okanogan River corridor has limited grazing in the Ellisforde area (less than 2,000 acres). During the summer, cattle graze at high elevations, on state, federal, and private lands. Historically, sheep were grazed on public lands, but in 1998 the last band of sheep grazed on public lands was sold off. Currently small flocks of sheep and goats, and some horses, are grazed on private parcels in the lower basin (Keller, 2001).

A federal grazing allotment system began in the early 1900s in response to complaints about the grazing and burning of the forests. Eligible ranchers were granted permits to graze on federal lands at specific times of the year at a fee for each animal per month. In the Toats Coulee area, now DNR and USFS lands, between 1906 and 1925 1,096 cattle grazed the area from June 1 to November 15 each year.

Table 8 lists nine grazing areas in the Okanogan Watershed. Forage quantity is summarized by Animal Units Months (AUM). DNR lands are divided into two categories, permitted land and leased land. All of the DNR permit land was inventoried between 1989 and 1996. Few of the DNR lease parcels have had recent range inventories.
Private lands that have not been inventoried in the past ten years are given an AUM of *Unknown*.

Table 8: Grazing Use in the U.S. Okanogan Subbasin.

Subbasins	Ownership	AUM	Acres
Similkameen & Sinlahekin	USFS permit	1,577	1,577
	BLM	4,178	4,178
	DNR lease	Unknown	Unknown
	DNR permit	13,640	13,640
	WDF&W	60	60
	Private not Inventoried	Unknown	Unknown
Spectacle Lake, Wannacut Lake, Aeneas Lake, Aeneas Creek	BLM	Unknown	Unknown
	DNR lease	Unknown	10,520
	DNR permit	300	1,497
	Private inventoried	2,778	19,068
	Private not Inventoried	Unknown	Unknown
Bonaparte, Siwash, Antoine, Mosquito, Tonasket, Nine Mile creeks	USFS permit	7,234	74,842
	BLM	Unknown	Unknown
	DNR lease	Unknown	10,500

Subbasins	Ownership	AUM	Acres
	Private inventoried	4,423	10,689
	Private not Inventoried	Unknown	Unknown
Omak, Wannacut, Tunk, Chewiliken Creeks	BLM	Unknown	600
	CTCR	5,100	86,766
	DNR lease	Unknown	4,160
	DNR permit	900	7,860
Joseph Flats, Omak Lake, East WRIA	CTCR	Unknown	Unknown
	WA State Parks	Not grazed	600
	Private	Unknown	Unknown
West WRIA	USFS permit	Unknown	5,100
	BLM	Unknown	2,084
	DNR lease	304	1,329
	Inventoried		
	DNR lease not	Unknown	Unknown
	Inventoried		
	WDF& W	N/A	2,660
	Private inventoried	2,127	12,676
	Private not Inventoried	Unknown	Unknown
Loup Loup, Tallant, Chiliwist Creeks	USFS	Unknown	920
	BLM	Unknown	Unknown
	DNR permit	6,017	38,520
	WDF&W	400	5,040
	Private not inventoried	Unknown	Unknown
Salmon Creek, North Fork Pine Creek, Brown Lake, Fish Lake	USFS permit	4,566	59,500
	BLM	1,651	9,463
	DNR lease	Unknown	Unknown
	DNR permit	650	7,004
	WDF&W	210	14,464
	WA State Park	N/A	120
	Private inventoried	2,858	14,205
	Private not inventoried	Unknown	Unknown
Okanogan River mainstem	BLM	Unknown	Unknown
	CTCR	Unknown	Unknown
	DNR	Unknown	Unknown
	Private not Inventoried	Unknown	Unknown
Pasayten Wilderness	USFS	Permit waived in 1999	

Livestock grazing practices have led to trampled streambanks, increased bank erosion and sedimentation, and changes in vegetation, including loss of native grasses, impacts to woody vegetation, and establishment of noxious weeds.

A 1970s rangeland evaluation indicated that 25 percent of rangeland in the basin was in good condition, 34 percent in fair condition, and 41 percent was in poor condition (PNRBC, 1977).

According to NRCS definitions, rangelands in fair to excellent condition provide adequate ground cover to protect the soil resource. Rangeland in poor to fair condition may not protect the soil, depending on the species composition and density. Areas in poor to fair condition may be prone to accelerated erosion. Accelerated erosion will likely degrade water quality.

Tonasket Ranger District Range Conditions

Tonasket Ranger District Range Conditions
Habitat conditions in range allotments on National Forest lands are in an upward trend. Most allotments have at least one localized area of overgrazing and trampling, and the Tonasket Ranger District focuses monitoring and restoration efforts on these areas. The District monitors range allotment conditions using a 1960s inventory as a baseline. In 1999 the District began conducting environmental analyses on all allotments. The allotments are assessed in clusters based on geologic features, and are being completed at a rate of one per year (Messerlie, 2001).

The USFS standards used to assess the condition of the riparian zones are contained in the Okanogan Forest Plan (USDA, 1989). On a forest wide basis, 24 percent of the all riparian acreage was monitored in 1997, a total of 268 acres (Table 9).

Table 9: Summary of USFS Riparian Area Acreage Monitored in 1997. (Percent of total acreage that meets or is moving towards forest plan objectives.)

	Currently Meets FPO		**Moving Towards FPO**		**Undetermined status**
	Verified	Estimated	Verified	Estimated	
% of Total Acreage	9	49	4	36	2

Livestock grazing no longer occurs in the Pasayten Wilderness. The existing allotment was created in 2000. The allotment still exists, but it would require an environmental analysis to reestablish grazing, and it is considered extremely unlikely to occur (Messerlie, personal communication, 2001).

Data gaps on range conditions on The Okanogan National Forest are centered around the lack of baseline monitoring data on water quality for riparian and stream systems. This type of information would include but is not limited to stream temperature, turbidity, and photo plots (OWSAC, 2000).

Cropland

Most of the Okanogan River valley bottom has been converted to agricultural uses, including cropland and orchards. Cropland in the Okanogan Basin is devoted to row crops, close-grown field crops, orchards, rotation hay and pasture, improved hayland, and summer fallow (Figure 8). Vegetables, berries, and nuts are also grown, but acreage figures were not available.

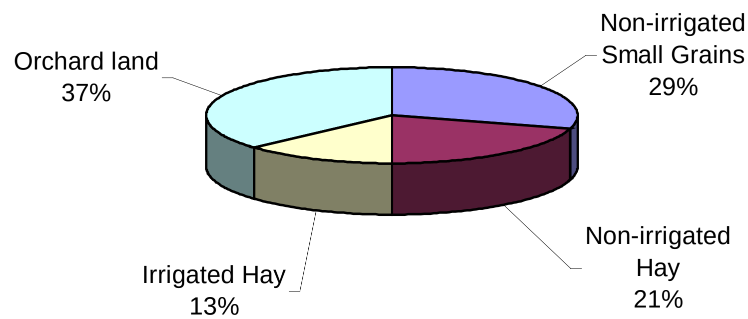


Figure 8: Major Crops of the Okanogan Basin (NCRS, 1998).

Mining

The only major placer mine in the Okanogan Basin is located on the Similkameen River, between Oroville and Nighthawk. That mine was active until recently.

The extraction of non-metallic minerals, including sand, gravel, gypsum, and limestone, is more extensive in the basin than hard rock mining, and has played a larger role in the economy of the region. There are a few gravel mine sites on the National Forest. The County maintains numerous gravel mines. The WDNR also maintains a few, and there are several on private property. Existing gravel mines are located well away from stream channels, and are probably not a major contributor of sediments to the streams.

Hard rock mines also have minimal impact on water quality and channel conditions. Most are small in size and are located away from stream channels. Some leaching may occur; it is not known if substances reach ground or surface water.

The Jessie Moore mine, in the North Fork Salmon Creek drainage, is the only patented claim within the National Forest boundary. Several claims have had plans for ground-disturbing activities in the last quarter-century, including the Silversmith Group in 1981, Quimine in 1981, and the Day Star Group in 1981. The Mar-Mac received got approval on its plans for road construction in 1983. That mine was restaked in 1993, and renamed Plata #1 (USDA, 1997).

In 1995, Okanogan County Health District conducted site hazard assessments on 25 mine sites in the Okanogan Basin:

- 6 sites were dropped because they were either active, or judged too insignificant to warrant full investigation.
- 3 sites were determined to be clean, and no further action was taken

- 16 sites were tested, and some elements were found at levels recommended for cleanup under the Model Toxics Control Act (MTCA). These elements included lead, arsenic, zinc, cadmium, copper, and antimony.
- A number of sites were identified as presenting physical danger to the public due to a variety of causes including rotten or inadequate shoring, or unstable rock masses.

Lead and arsenic in both soil and water were the metals more frequently found above the MTCA's recommended cleanup levels. Lead binds to soil particles and tends to not move significantly in the soil column. Arsenic is more prone to a slow migration through the soil column and into the groundwater.

The WSDOE will conduct site hazard assessments at each of the identified sites, as time and staffing allow, to determine the severity of the problem, rank the sites, and initiate remediation, if required (OWSAC, 2000).

The USEPA recently closed the Texas Kaaba mine, upstream of the Enloe Dam.

Transportation System

History

The road and rail systems in the Okanogan Basin were established around the turn of the century. A web of routes was developed along traditional travel corridors, typically along rivers and streams. Many of the current road locations were established at that time (Okanogan Conservation District).

During the 1920s and 1930s a number of railroad lines were built in the forested drainages of the basin. The most notable and by far the longest lasting of these was the narrow-gauge rail line into the Omak Creek watershed (Lewis, 1980). The construction of this line included a railroad grade through Omak Creek Canyon near St. Mary's Mission, and hard rock excavation was required. The crew removed 10,000 cubic yards of rock from the canyon (Lewis, 1980). Much of this was blasted or dropped into Mission Falls directly below. The extra material blocked anadromous fish passage to the waters above the falls until 1999, when the Colville Tribe and NRCS finished removing the material from the channel.

The Biles-Colman narrow-gauge railroad was unusual in that it was well maintained throughout its history. The railroad ties were not treated with creosote, as is common still, because of the ready access to timber at the mill (Lewis, 1980).

Current Condition

There are approximately 85.5 miles of railroad in the Okanogan River Watershed (OWSAC, 2000). Almost all of the lines are located in the Okanogan River corridor. The main line is located within one half mile of the Okanogan River, from its confluence with the Columbia River to Oroville. There is no new construction of railroad lines planned in the Okanogan River Watershed.

There are 4,357 miles of road in the Okanogan Watershed (WDNR, 1996). The Okanogan County road system includes less than 900 miles, with about 33 miles of county road within 200 feet of a stream or river. There is no comprehensive database quantifying the unimproved roads currently within the watershed. Unimproved roads are unpaved, and may or may not be graveled.

Roads are considered to be the greatest contributing source of sediment to streams in the basin. Sedimentation is highest at road crossings over stream channels, along roads in close proximity to streams, along cut and fill slopes, and at roads and ditches that drain to stream channels. Private roads that access multiple parcels often do not have a coordinated maintenance program, leading to increased erosion and sedimentation.

Roads affect streams by accelerating erosion and sediment delivery, altering channel morphology, and changing the runoff characteristics of watersheds (Furniss et al., 1991). In addition, noxious weeds tend to spread along roads, increasing erosion potential. Herbicide treatment of noxious weeds along roadsides can lead to contamination of nearby streams through accidental spills, direct runoff, or infiltration (USDA, 2000).

Road construction is one of the largest impacts in terms of water pollution in the basin. Several thousand acres of land have been stripped of vegetation during the initial construction phases and subsequent maintenance operations, leaving the underlying soil exposed to the forces of wind and water.

Roads composed of native material with little rock also do not hold their shape well when soft and wet, as they often are during the autumn, winter breakup, and spring. Road use at these times can cause rutting of the road surface, compromising road drainage and greatly increasing erosion. Follow-up grading of the road surface improves driveability but simply disguises the chronic erosion, which may regularly damage water quality. Grading off soft, wet road surfaces produces sunken roads with few opportunities for drainage.

Water crossing and fill failures have occurred regularly during high water periods, degrading water quality and requiring expensive repairs. In places, erosion of road fills is chronic, due to faulty road drainage or lack of fill protection such as rock armoring or vegetation.

In addition to sediments, runoff from road surfaces carry contaminants such as heavy metals, litter, rubber particles, asphalt materials, herbicides, de-icing compounds, and asphalt sealant.

The Washington State Department of Transportation (WSDOT) maintains almost 175 miles of highway in the watershed and has made significant changes to their maintenance operations in the past several years to provide better protection to the water resource. These measures include:

- Use of vacuum trucks to clean catch basins and bridge drains rather than flushing them out, with the material being recycled or properly disposed of.
- Application of liquid deicers in the fall and spring, in lieu of sanding.
- Modification of sand specifications so a "cleaner" sand is being used.

The Endangered Species Act listing of the steelhead trout influenced WSDOT maintenance operations, including weed control operations, culvert cleaning, sanding and deicing practices (OWSAC, 2000). WSDOT has numerous culverts in need of cleaning.

Appendix A includes a list of all culverts identified by Washington State Department of Fish and Wildlife (WDFW). Many stretches of state highway are in close proximity to streams, and it is difficult for WSDOT to keep the roads safe for travel while protecting the streams from contaminants.

Although Okanogan County Public Works does not have in place written procedures for roadway maintenance practices, the department is in the process of developing guidelines (OWSAC, 2000).

Road density

Information on road density (miles per square mile)is available for two subbasins:

- Salmon Creek - 2.2-miles/sq. mile (USDA, unpublished data)
- Omak Creek - 6.38 miles/sq. mile (NRCS, 1995)

Road density in most subbasins in the basin is exceeds 4 miles/sq. mile, which is the figure above which sediment delivery is considered to be greater than natural erosion rates (Cederholm, 1981). Sediment delivery from roads also depends on factors such as distance from the stream, slope, vegetative cover, and precipitation.

Roads in Riparian Areas

The USFS determined the miles of road within 200 feet of stream channels for seven sub-watersheds (Table 10). At this proximity, roads are likely to increase sediment delivery to streams considerably. However, site characteristics and maintenance standards play a role in sediment delivery also.

Table 10: Road Miles within 200 feet of U.S. Streams in the Okanogan Subbasin.

Sub-watershed	Non-USFS	Closed USFS	Open USFS	Total Miles of Road
Bonaparte Creek	41.4	1.7	5.1	48.2
Mainstem Okanogan	56.0	4.7	1.5	62.2
NE Okanogan	52.4	2.4	10.7	65.5
SE Okanogan	25.4	0.9	0.7	27.0
SW Okanogan	31.1	0.1	0.7	31.9
Salmon Creek	19.6	6.6	19.9	46.1
Similkameen River	43.1	0.2	7.2	50.5

Source: USFS, 2000

Another Okanogan National Forest (ONF) analysis calculated the USFS road miles within 50 feet of a stream, as well as the total number of road crossings over streams by subbasin (Table 11).

Table 11: Roads within 50 Feet of Streamchannels in the Okanogan Subbasin (USDA, 2000).

Drainage	Miles of road within 50 Feet of Stream	Road Crossings over Streams
Bonaparte	2.9	47
Myers	2.5	41
NE Okanogan River	4.3	46
Okanogan Mainstem	4.5	87
Salmon	6.4	109
Similkameen	0.5	16
Toroda	12.2	85
WF Granite	2	25
WF Sanpoil	9.5	131

Many unimproved roads in the basin are constructed of native material with little ballast or surfacing. Such road surfaces erode readily, creating a need for frequent cross drainage.

Railroads

Railroads in close proximity to streams also increase sediment delivery. Herbicide use along right of ways creates a risk of water contamination. The only active railroad is the Cascade-Columbia River Railroad. This amounts to 0.3 mile of active railroad per square mile in the entire Okanogan River Basin. For this reason, railroads contribute very little to sediment and contaminant delivery to streams.

There is no new railroad construction planned in the Okanogan Basin. The current emphasis is on maintaining the (100-foot average) right-of-ways. Maintenance includes periodic brush cutting, and chemical application of herbicides (Table 12), and occasional track or railroad tie replacement.

Table 12: Chemicals Applied to Railroad Right-of-ways for Maintenance by the Cascade & Columbia River Railroad As Needed

Chemical	Application Rate	Chemical	Application Rate
Diuron	6-8 lbs./acre	2-4-D	1-2 qt/acre
Oust	2-3 oz/acre	Tordon	1-2 qt/acre
Telar	1-3 oz/acre	Banvel	1-2 pt/acre
Krovar	6-8 lbs./acre	Escort	0.5-1.5 oz/acre
Round Up	2 qt/acre		

Noxious Weeds

Current Conditions

Location and extent of noxious weed infestations are currently being mapped by the Okanogan County Noxious Weed Control Office using the Geographic Positioning System (GPS). All Class A and some Class B designates were mapped in 2000. In 2001, they will continue to map Class B weeds (Sheila Kennedy, personal communication, 2001).

The Okanogan National Forest has mapped noxious weed infestations on the GIS system, and continues to add more sites. They currently have 31,000 acres weed infestations across the forest, including 24,000 acres of very dense knapweed.

The ONF completed environmental assessments for their Integrated Weed Management Program in 1996, 1999, and 2001. The 1996 EA covered 34 sites, on a total of 3000 acres. The 1999 EA covered 15-18 sites, a total of 75 acres. The 2001 primarily covers the road system, a total of 1700 miles of road.

Effects on Water Quality and Riparian and Aquatic Habitat

Noxious weeds alter riparian vegetative cover by reducing the complexity of vegetative layering and diversity, on which indigenous aquatic and semi-aquatic species rely (USDA, 2000). Infestations on stream banks may lead to increased sediment delivery when weeds replace native, fibrous-rooted plants with tap-rooted weeds, such as knapweed. The weeds use available water, but do not provide enough ground cover to prevent erosion. (USDA, 2000).

Herbicide treatment of weeds also impacts streams if the herbicide reaches the channel. Herbicides may enter surface or shallow ground water when sprayed directly on running or standing water, or through drift or soil erosion, or in the case of an accidental spill.

Herbicides may indirectly affect surface waters by reducing the riparian zone vegetation, leading to increased water temperatures (USDA, 2000). Herbicides may contaminate water through accidental spills, direct application to water bodies, surface runoff or movement through the soil (USDA, 2000).

Weed treatment under the ONF preferred alternative for the Integrated Weed Management program would use a combination including herbicides and hand pulling, flower head removal, mowing and scraping. In riparian areas, glycophosphate would be sprayed during spring or fall.

Irrigation Districts

There are nine irrigation districts, reclamation districts, and canal companies operating in the Okanogan Watershed (Table 13). These water providers comprise the bulk of irrigation water delivery from surface water sources to approximately 24,710 acres (OCD, 1989). Table 14 displays information about surface and groundwater rights in the basin.

Table 13: Irrigation Districts of the Okanogan Basin.

Irrigation District	Source	Irrigated Acres	Length	Flow
Okanogan Irrigation District	Salmon Ck, Okanogan R.	5,032	50 mi. piped. 7.6 mi. lined canal	15,000 acre ft/yr.
Oroville Tonasket Irrigation Project	Similkameen R., Lk Osoyoos, Okanogan R.	10,300	110 mi. pipe 10 mi. canal	41,200 ac ft/yr.
Whitestone Irrigation and Power Company	Toats Coulee	3,000	16 mi. pipe 14 mi. lined canal	45 cfs max

Irrigation District	Source	Irrigated Acres	Length	Flow
Pleasant Valley Irrigation Project	Loup Loup Creek, Okanogan River	2,000	3 mi. pipe 3 mi. canal	17 cfs max
Helensdale Irrigation District	Loup Loup Ck., Okanogan River	225	2 mi. pipe	
Brewster Flat Irrigation Project	Columbia River @ Chief Joseph Dam	2,832	28 mi. pipe	60 cfs max
Aeneas Lk. Irrigation District	Aeneas Lake	1400	4 mi. pipe	12 cfs
Alta Vista		40	1 mi. pipe	1 cfs
Black Bear	Sinlahekin Ck	105	2.5 mi. pipe	2 cfs

Table 14: Summary of Water Rights in the Okanogan Basin (U.S. Only) (WSDOE, 1995).

Water source	Number of permits	Quantity (acre feet)	Area (acres)	Percent Used for Irrigation
Surface	470	105,414	67,443	98%
Ground	307	39,344	10,437	56%

The most common irrigation system is a permanent solid-set sprinkler using micro sprinklers or conventional impact sprinklers. Overhead permanent sprinkler systems are selectively used. Some irrigation systems may be used for spring frost control efforts and for summer temperature modification. Irrigation methods have changed from rills and clean cultivation to grass cover crops with sprinklers to micro-sprinkler systems. Advances in soil moisture monitoring technology have accompanied these advances in irrigation methods, although not all growers are taking advantage of them. These advances have increased the overall efficiency of the application of water.

DAMS

There are 20 dams in the U.S. portion of the basin: 9 state, 7 private, 3 federal, and 1 PUD (Table 15 and Appendix B). There are 13 vertical drop structures on the Canadian side (NMFS, 2000). Zosel Dam (RM 78) controls the level of Osoyoos Lake. Reconstruction work in 1987 improved fish passage into the lake.

A McIntyre Dam on the Okanogan River below Lake Vaseauex, B.C., is the upstream barrier to migratory fish most years. In high water years fish may access Lake Vaseauex.. The Similkameen River is impassable at Enloe Dam, an abandoned power generation facility 8.8 miles above the mouth. It blocks access to more than 95 percent of the potential anadromous fish habitat in the Similkameen River. Recently there has been interest in relicensing the Enloe Dam, and fish passage alternatives are being investigated.

Table 15: Dams in the U.S. Okanogan Basin (Streamnet, 2000).

Dam Name	Stream Name	Ownership	Year completed	Dam Length (ft)	Height (ft)t	Normal Storage (acft)	Max Storage (acft)
Fanchers Dam	Antoine Cr	Private	1926	450	68	500	600
Bonaparte Lake Dam	Bonaparte Cr	Private	1957	180	9	535	995
Stout Reservoir Dam	Chiliwist Cr	Private	1958	250	25	18	24
Horse Spring Coulee Dam	Columbia River	Private	1924	650	67		7,000
Fish Lake Dam	Johnson Cr	State	1920	50	7	2815	2,815
Schallow Lake Dam	Johnson Cr	State	1954	330	13	46	76
Osoyoos Lk. Control Dam (Zosel)	Okanogan R	State	1986	321	40	1,700	55,000
Leader Lake Dam	Okanogan R & tribs	Private	1910	300	53	5,900	6,750
Leader Lake Saddle Dam	Okanogan R & tribs	Private	1910	650	11	1,000	1,850
Little Green Lake Dam	Okanogan R & tribs	State	1959	88	11	400	730
Salmon Lake Dam	Okanogan R & tribs	Federal	1921	1,250	54	15,700	17,280
Sasse Reservoir Dam	Okanogan R & tribs	State	1910	140	10	60	60
Spectacle Lake Dike	Okanogan R & tribs	Federal	1969	1,110	25	13,450	14,080
Whitestone Lake Dam	Okanogan R & tribs	Private	1930	375	9	2,144	2,720
Conconully	Salmon Cr	Federal	1910	1,075	72	13,000	16,570
Enloe	Similkameen R	PUD	1923	316	54	400	400
Blue Lake Dam	Similkameen R & tribs	State	1923	1,500	32	4,416	4,416
Sinlahekin Dam No. 1	Sinlahekin Cr	State	1949	180	14	175	333
Sinlahekin Dam No. 2	Sinlahekin Cr	State	1949	248	18	52	82
Sinlahekin Dam No. 3	Sinlahekin Cr	State	1950	285	9	304	593

Fish Passage

Fish passage is blocked by dewatering in Salmon Creek, by elevated temperatures in the Okanogan River, and by Enloe Dam on the Similkameen River. Until 1999, fish passage was blocked on Omak Creek at two sites.

Water Quality

There are serious water quality concerns in the Okanogan Basin. The Okanogan River and several of its tributaries are on the Washington State 303(d) 1998 list (Impaired and Threatened Waterbodies Requiring Additional Pollution Controls) for "failure to meet water quality standards including temperature, dissolved oxygen, pH, and fecal coliform" (WSDOE, 1998) (Table 16).

Table 16: Okanogan Basin Water bodies on the Washington State 1998 303(d) List.

Water Body	Water Quality Issues
Okanogan River	temperature, DO, fecal coliform, PCB-1260, PCB-1254, 4,4'-DDE*, 4,4'-DDD*
Similkameen River	Temperature, arsenic
Salmon Creek	Instream flow
Nine-mile Creek	DDT
Tallant Creek	DDT
Lake Osoyoos	4,4'-DDE*, 4,4'-DDD*

*break-down products of DDT

WSDOT is currently in the technical assessment phase of developing total maximum daily loads (TMDLs) for PCB and DDT in the Okanogan Basin. This is preliminary data-gathering step to assess the extent of contamination. The WSDOE establishes TMDLs as the foundation of a basin-specific strategy to improve water quality. The WSDOE may establish statewide TMDLs for temperature-related parameters.

The Okanogan and Similkameen rivers are classified by the State of Washington as Class A waters (Chapter 173-201-A-130 WAC, 1992). Classes range from A to AAA, with AAA being the highest quality. Class A waters are required to meet, or exceed, the standards established for the various uses including: water supply, recreation, fish (migration, rearing, spawning, and harvesting), wildlife, agriculture, and commercial uses.

Compliance for Class A waters includes:

- Temperature should not exceed 18^0C, and pH should occur within the range of 6.5 to 8.5.
- Dissolved oxygen should not fall below 8 mg/L.
- Fecal coliform counts should be below the geometric mean of 100/100ml.

When natural conditions result in water temperatures exceeding 18^0C, no discharges will be allowed which raise the receiving water temperature by greater than 0.3^0C. In addition, the USEPA has established the drinking water standard for nitrate at 10 parts per million.

Surface erosion from clean cultivation and rill irrigation was a serious problem in the Okanogan Valley during the 1960s and 1970s. This soil loss has been greatly reduced as row crops have changed to alfalfa hay and irrigation has been converted to overhead sprinklers. Adoption of "Best Management Practices" (BMPs) by the USDA has also contributed to reduction of soil losses and erosion. Best Management Practices are defined as "a practice or combination of practices, which are the most effective means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals" (USDA, 1998).

Water Quality Monitoring

There are several water quality monitoring projects in the Okanogan Basin:

- The WSDOE monitors ambient water quality conditions on the Okanogan River at Malott and Okanogan. These sites were established in 1977. Data collection has been sporadic at times, but sufficient data has been collected to demonstrate general conditions and trends.
- The USGS collects water quality information at Malott on a monthly basis. This station was established in the mid 1970s.
- The Okanogan Conservation District (OCD) began a water quality monitoring program in May 2000. There are 38 sites in 11 subdrainages. All sites are tested for pH,

dissolved oxygen (DO), temperature, turbidity, conductivity, and total dissolved solids. Seven of the sites are also tested for ammonia-nitrogen, nitrate-nitrite, total per sulfate nitrogen (TPN), dissolved phosphorus, total phosphorus, total alkalinity, total suspended solids, and fecal coliform. During storm events sites are tested for the presence of heavy metals. OCD also manages a pesticide and organochloride scan, and a macroinvertebrate survey.

- In 1995, the WDNR and the WSDOE cooperatively established several water quality monitoring sites on the Loomis State Forest. The purpose of these monitoring sites is to detect long-term changes in water quality (if any) as a result of management practices on the forest. A macro-invertebrate assessment and stream channel condition assessment is conducted annually at each of the study sites. The project was developed in response to the Loomis Forest Landscape Plan (WDNR, 1996). Three treatment sites and two control sites are measured annually for water quality parameters such as temperature, DO, pH, salinity, and stream flow. In addition, stream channel conditions are assessed, macroinvertebrates sampled, and there are established photo points.

The following discussion is based on the WSDOE and USGS data.

Nitrogen

The nitrate values recorded on the Okanogan and Similkameen Rivers are well below any action level for health standards and are thus acceptable for all Class A water uses. Common sources for nitrogen include on-site sewage disposal systems, discharges from municipal sewer treatment plants, irrigation system return flows, fertilizer applications for both agricultural and residential uses, waterfowl congregating on the waterbody, and atmospheric deposition.

Dissolved Oxygen

Dissolved oxygen (DO) in the Okanogan River system is generally at or above saturation levels at all sites, even during the summer months when the water temperatures are elevated. The Malott has the lowest saturation values. This is predictable, since the monitoring station is located downstream of the largest municipalities in the basin, where sewage and stormwater impacts are highest. In addition, there is very little turbulent water between the Okanogan monitoring station and the Malott station to facilitate reaeration.

There are a few data sets available for the Malott site that include values over the course of a single day. These data sets show a 10 to 12 percent increase in DO levels from the morning to mid-day readings. This may indicate the presence of algae in the river that produce oxygen during the daylight hours.

Temperature

The Okanogan and Similkameen rivers both have elevated temperatures during the months of July and August, and the Okanogan maintains elevated temperatures into September. Water temperatures are also high on the Canadian portion of the drainage (Province of British Columbia, 1996). Temperatures in the Canadian portion of the river were recorded to remain higher than 21^0 C for many days in July and August (Hansen, 1993). Elevated temperatures are considered to be a result of both natural conditions, such as the north-south orientation and the low gradient, and human-influenced conditions, including lack of riparian vegetation, elevated sediment delivery, dam operations, and irrigation withdrawals (NMFS, 2000).

pH

The average pH values measured in the basin have risen approximately 0.3 point over the last 20 to 30 years. This puts pH at the upper limits of the desired range. This alkaline condition may exert a stabilizing effect on the heavy metals by keeping the metals sorbed onto the soil particles and sediments, and out of solution (WATERSHEDSS, 1997). Influences on the pH level include acid mine drainage, atmospheric deposition (acid rain), calcium, calcium carbonate, effluent water, and land use practices.

Fecal Coliform

Data collected from 1977 to 1997 indicate that fecal coliform is not a concern at existing monitoring sites. The Malott station had 9 exceedences in 163 recorded samples; the Okanogan station had 5 exceedences in 128 observations; and the Oroville stations had 0 exceedences out of 190 observations on the Okanogan, and 1 exceedence out of 208 observations on the Similkameen (DOE - EAP Lab, 1977-1997). These results are all well below the the State water quality standards, which allow for up to 10 percent of the samples to exceed the published standard as long as the mean value of the samples is below 100 colonies per 100 ml.

Values recorded varied widely, with high peak values interspersed with very low values. This suggests that the source was not a constant contributor, such as a regular sewage treatment plant discharge. The source could be the result of flood events that caused overloading of the sewage treatment plants with a subsequent discharge of less than fully treated wastes. Other possible sources of contamination include an animal carcass in or near the river; rain events that cause surface runoff from animal stockyards or feedlots; wildlife feces adjacent to streams; or a concentration of waterfowl in the vicinity of the monitoring station.

Turbidity

Turbidity was low at Malott, Okanogan, and Oroville for the months of May, June, and July (1978-1996). The May average for the stations was 16.5, 7.7, and 2.9 nephelometric turbidity units (NTUs), respectively, on the Okanogan, and 8.7 NTUs on the Similkameen. During June (peak flow month), the values were 17.1, 21.8, and 2.2 NTUs on the Okanogan and 13.7 NTUs on the Similkameen.

The peak values recorded on the free-flowing sections of the Okanogan and Similkameen were collected in the late fall and winter months. It appears that the highest sediment loads are produced during extreme storm events rather than from normal snowmelt.

Sand has been reported to be a problem with irrigation pumps withdrawing water from the river system. The months of May and June have the highest average readings of suspended sediment, a period during which significant quantities of water are withdrawn. Additional monitoring of the river for sediment over the entire vertical water column would be desirable and a grain size analysis conducted to assist in identifying the sources. Primary sources for sediment are erosion from forest fire burn areas, agricultural practices, cut and fill slopes on roadways, highway maintenance practices, construction sites, logging operations, and strip mines (including gravel operations).

Sedimentation

Sedimentation is a major water quality concern in the Okanogan Basin. Naturally erosive soils coupled with high road density, timber harvest practices, and livestock grazing practices have resulted in accelerated sediment delivery to the stream system.

Several historical developments have affected sediment and runoff rates since European settlement in the basin. Major impacts began in the 1880s when mining and timber removal began. Some hillsides were denuded, resulting in high sediment yields in the 1894 flood, and subsequent high flows. At low elevations, overgrazing coupled with low precipitation has resulted in lower infiltration rates and higher runoff. As described above, roads are considered to be primary causes of increased sediment delivery to Okanogan Basin stream channels.

The effects of sedimentation include channel widening; loss of pool habitat; shallower, broader channels; elevated water temperatures; and loss of spawning and rearing habitat.

Surface erosion on agricultural bottomlands and mass wasting on adjacent hill slopes were serious problems in the 1970s, when clean cultivation and rill irrigation were extensively used in the U.S. part of the Okanogan Basin. This soil loss has been reduced, though not eliminated, through a change of crops, and the adoption of Best Management Practices (BMPs) by the USDA (NMFS, 1998). The sub-watersheds with the highest levels of sheet and rill erosion are the Similkameen River, Bonaparte Creek, upper Salmon Creek, and Sinlahekin Creek.

The subwatersheds of Bonaparte Creek, Salmon Creek, Antoine Creek, and, to a lesser degree, Omak Creek had noticeable streambank failures. Some of these areas have high width to depth ratios, and lack streambank vegetation and woody debris (NRCS, 1998).

In 1998 NRCS assessed the sediment yields of 30 subwatersheds in the Okanogan Basin using the Pacific Southwest Interagency Committee (PSIAC) sediment yield model (cite), a road bank erosion assessment model, and a watershed yield comparison method (OWSAC, 2000). The drainage area upstream of Lake Osoyoos was not included because the lake acts as a sediment trap. This study was a broad assessment, and the estimates are best used as a relative comparison of yields between large subwatersheds. The PSIAC model is most effective when an interdisciplinary approach is used to evaluate the factors that affect the movement of sediment.

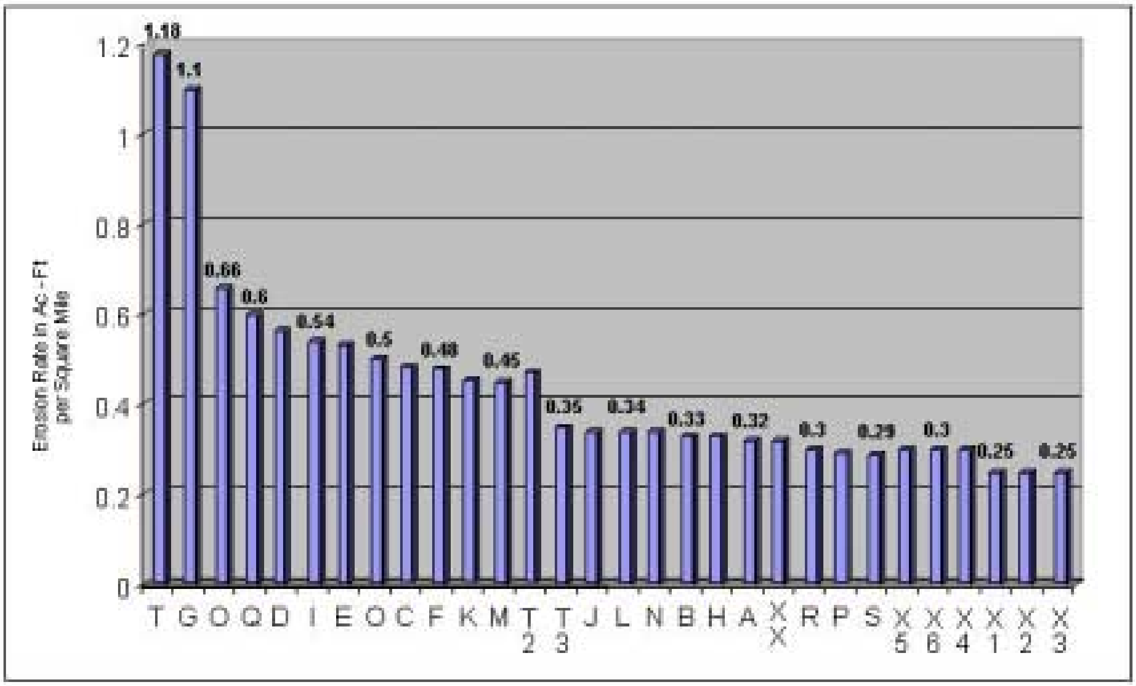


Figure 9: Erosion Rates in 30 Okanogan Subwatersheds (NRCS, 1998).

Key:

Tl-Similkameen River	K -Omak Creek	XX-Columbia inter-WRIA
G -Bonaparte Creek	M -Loup-Loup Creek	R -Aeneas Creek
01-Salmon Upper (NW)	T2-Ashnola	P -Browns Lake
Q -Sinlahekin River	T3-Pasayten	S -Spectacle Lake/Whitestone
D -Mosquito Creek	J -Wannacut Creek	X5-Aeneas Lake
I -Tunk Creek	L -Chiliwist Creek	X6-Wanacut Lake
E -Antoine Creek	N -Tallant Creek	X4-N. Fork Pine Creek
02-Salmon-Lower	B -Nine Mile Creek	XI-Omak Lake
C -Tonasket Creek	H -Chewiliken Creek	X2-Duley Lakes/J. Flats Area
F -Siwash Creek	A -Okanogan Interfluve	X3-Fish Lake Basin Area

The Similkameen River and Bonaparte Creek are the largest sediment contributors to the Okanogan River, yielding 531,295 tons/year, or 33 percent of the total yield. These two subdrainages account for 9.5 percent of the total land area modeled. These drainages have the highest levels of road bank erosion per unit area. The Similkameen has the highest erosion rate, at 3.5 tons per acre (NRCS, 1998).

The Okanogan mainstem contributes 12.4 percent of the total sediment yield, and accounts for 12.4 percent of the total area modeled.

In 1972, the USGS studied the Enloe Reservoir to determine how the Similkameen and Okanogan rivers would be affected by removal, transport, and deposition of sediment deposited behind Enloe Dam if the dam were removed. The average annual suspended sediment discharge at Nighthawk, located 6 miles above the Enloe Dam, was 134,000 tons per year. Over a 51-year period, 2.4 million tons of sediment, primarily sand, settled into the Enloe Reservoir. The average yearly amount of sedimentation from 1920 to 1972 in the Enloe Reservoir was 47,000 tons. Depth at the Enloe dam rose an average of 0.65 feet per year from 1920 to 1972 (USGS, 1972).

Mass Wasting

Landslides have been noted on steep glacial outwash terrace escarpments and silty glacial lake deposits in some of the forest basins in the western portion of the basin.

Follow-up analysis of a slide which occurred in the Cecile Creek drainage in May 1995 points both to localized natural soil instability and loss of tree root strength following harvest as contributing factors.

Stormwater

The volume and rate of stormwater runoff is directly related to how much of the basin is covered by asphalt and other impervious surfaces. Okanogan Basin in primarily rural, and the area covered with impervious surfaces is low compared to urban areas. However, road density is high in the population centers, and these tend to be located close to major rivers and streams. Several stream channels are paralleled by roads. Also, there is a number of rural land use activities that contribute to stormwater, such as culvert discharge and overland surface flow.

Neither Okanogan County nor any of the incorporated communities within the watershed have a comprehensive stormwater management plan or erosion and sediment control ordinance in place to provide water quality protection. However, floodplain, shoreline, and zoning regulations are routinely used to review and adapt land use applications to control surface water runoff (OWSAC, 2000). The WSDOE requires that all disturbed sites greater than 5 acres obtain National Pollutant Discharge Elimination System (NPDES) coverage under the General Permit issued for this activity. This entails the filing of a Notice of Intent to conduct land disturbing activity, and the use of Best Management Practices with regard to erosion and sediment control.

The cumulative effects of development have the potential to impact stormwater in the Okanogan River Watershed. There are hundreds of vacant parcels within the watershed and most of them were created from short plats that did not require erosion control drainage plans. As development occurs on these lots, cumulative stormwater and erosion problems may develop that will not be addressed by drainage plans for single family residences. Without an overall plan or outline for movement of stormwater over and through the landscape, solutions to stormwater problems will not be comprehensive or an efficient use of funds. Regional stormwater management planning conducted on a basin-wide scale is beneficial because it incorporates the entire watershed and allows for analysis and planning to address cumulative stormwater impacts (Okanogan Conservation District, 2000).

Nine sites in the Okanogan Basin were identified on the WSDOE 1998 Hazardous Sites List. Five of these sites were service stations, and seven had completed a remedial action plan or were in process. The two sites without a remedial action plan in place were the Tonasket Post and Rail operation and the Loomis Chevron (both were ranked as a level 5 site - the lowest ranking).

There are 56 active stormwater permitted industries in the Okanogan River Watershed. The amount of impact from the unpermitted industries is unknown (Okanogan Conservation District, 2000).

Stormwater management within the urban areas of the watershed is the responsibility of the individual towns and cities.

Sewage

Historically, on-site sewage (OSS) disposal systems have been used for the treatment and disposal of human wastes in the unincorporated areas of the Okanogan River Watershed. In the incorporated cities and towns of the watershed, this was also true until the development of collection and centralized treatment systems. These were established in Okanogan, Omak, and Tonasket in the late 1940s, and in Conconully in 1980.

The Okanogan County Health District (OCHD) oversees on-site systems under 3,500 gallons per day. Design standards take into consideration soil type and depth, slope, and proximity to water bodies when approving the siting and design of a system (Okanogan County Health District, 1996). On-site systems between 3,500 gallons and 14,500 gallons per day are permitted by the Washington State Department of Health. Systems over 14,500 gallons per day require WSDOE approval. All systems over 3,500 gallons per day require approval by the Okanogan County Public Works Department prior to construction.

The CTCR oversees the installation and maintenance of on-site systems on reservation lands. The Tribe prepared an Onsite Wastewater Management Plan in 1982 as part of their 208 Water Quality Management Plan. This document outlines the procedures for the design, installation, and maintenance of on-site systems on reservation lands. The County Health District works in close cooperation with the CTCR on sewage disposal issues that involve nontribal members that own land within the reservation boundary (Montgomery, 1982).

The OCHD has a database of on-site systems (OWSAC, 2000).

The disposal of the biosolids (septage) removed from septic tanks, as well as toilet vaults and porta-potties during routine maintenance is typically handled in Okanogan County through land application. The biosolids are spread on the surface of the ground, lime is applied to stabilize the material and reduce odors and pest attraction, and it is then tilled in. Each septic tank pumper in Okanogan County has one or more permitted sites for the disposal of septage. This is necessitated in part by the fact that none of the publicly owned treatment plants is designed to treat septage (OWSAC, 2000).

The publicly owned sewage treatment facilities in Omak, Okanogan, Oroville, Tonasket, and Conconully are all operated by the respective municipalities under the guidelines and overview of the WSDOE. Oroville and Omak employ oxidation ditch technology, Okanogan uses rotating biological contactors, and both Conconully and Tonasket use lagoon systems.

Like on-site sewage systems, treatment plant effluent can have detrimental impacts on receiving water quality. In the Okanogan Basin in the U.S., the Omak and Okanogan municipal treatment plants discharge to the Okanogan River, and the Oroville plant discharges to the Similkameen River. The WSDOE, through NPDES permit process, sets the monitoring requirements and testing schedule for each of the treatment plants, and collates and reviews the collected data. The Conconully system is a lagoon treatment process that employs land application for disposal of the effluent by means of irrigation. The Tonasket treatment plant discharges its effluent to groundwater rather than directly to the river, although the discharge point is only 50 to 60 feet from the Okanogan River.

There is some conflicting information regarding fecal coliform contamination in the Okanogan River Watershed. The 1994 supporting documents to the §305(b) report (WSDOE, 1994), state that the Okanogan and Similkameen are both impaired for use because of fecal coliform contamination. The 1996 §305(b) report (WSDOE, 1996), does not list fecal coliform as one of the parameters exceeding standards on the Okanogan or Similkameen, nor does the 1996 §303(d) list (Millam, correspondence, 1996). A review of the WSDOE EAP data collected over the past 20 years at Malott, Okanogan, and Oroville shows occasional samples that exceed parameter standards but no pattern of violation (WSDOE, 1977-1997).

In 1988, the WSDOE conducted a receiving water survey at the Okanogan wastewater treatment plant to determine the effects of the treatment plant discharge on water quality during low-flow periods. The results, while not conclusive, did demonstrate that the effluent grab samples contained higher fecal coliform counts than were permitted (Carey, 1990). In the last year, the effluent fecal coliform counts have averaged considerably lower than the permitted values, reflecting improved disinfection of the effluent prior to discharge. The river reach containing the Okanogan wastewater treatment plant outfall has been proposed for the 1998 §303(d) list for fecal coliform contamination as a result of this study.

All soil types in the Okanogan River Watershed have been identified by the NRCS as having features unfavorable for effective sewage drainfield use. A review of the Soil Survey of Okanogan County Area shows that all soil types existing on a side slope of 8 percent or more were listed as having moderate restrictions for siting septic tank absorption fields. This classification was done when leachfields were typically installed as level beds and therefore slope became a consideration. The technology utilized in the construction of an OSS has advanced greatly over the last 30 years, and the restriction imposed by slope is no longer a major concern.

Fish and Wildlife Resources

Fish and Wildlife Status

History

Over hundreds of years northwest Native American tribes developed an economic and social dependence upon Columbia River salmon. Fishing areas such as Celilo Falls and Kettle Falls were focal points from May through August, during salmon runs that reached

7.5 million per year. Several tribes gathered to net, spear, dry, and trade salmon. Early European explorers and trappers remarked at the "millions" of salmon ascending Kettle Falls. As many as 40,000 salmon may have been taken by native fishermen around Kettle Falls in the early 1800s. In the mid-1800s there was a marked drop in the size of some salmon runs. Major salmon shortages in the mid-Columbia were noted by whites in the late 1820s, and early 1830s and at Kettle Falls in the 1880s. Indians were starving and had abandoned some of the traditional fishing spots due to lack of returning adult salmon. This points to the unpredictability of ocean rearing and survival conditions, which could be a contributing factor in today's declining runs (Schalk, 1986).

By the mid-1800s, European settlers in the Columbia River area established net sites and built commercial canneries in the central and lower reaches of the Columbia River. This harvest peaked at 2.3 million fish in 1883. From 1889 to 1922, the resource sustained an average annual harvest of 25 million pounds. Average yield was approximately 1.3 million fish from 1890-1920. Runs continued to decline steadily, and by 1958, the harvest was down to about 5 million pounds. The early canneries depleted some of the salmon runs before the first dams were built.

As spring and summer chinook runs declined at the turn of the century, the harvest shifted to fall chinook. By 1912, the ocean commercial fishery was established in the Columbia River delta, with a fleet of 1,000 trolling boats.

Ten dams were planned for the Columbia River during the 1930s to control flooding and produce cheap electricity. In 1933, Rock Island Dam was the first completed, followed by Bonneville Dam in 1938, and Grand Coulee Dam in 1941. Fish passage was not provided at Grand Coulee Dam, although the biology and engineering were available at the time. As a result, salmon spawning was eliminated upstream of the dam.

In 1956, the pool behind The Dalles Dam was flooded, eliminating Celilo Falls, the traditional tribal fishing area (NW Power Planning Council, 1992). By 1958, all non-Indian commercial fishing in the Columbia River above Bonneville Dam had ended. In 1967, Hells Canyon Dam was completed and blocked upstream migration of adult chinook salmon on the upper Snake River (NW Power Planning Council, 1992). During this period, the human population in the Columbia Basin grew as a result of the cheap electric rates and improved irrigation.

The remaining runs were lost or reduced due to hydroelectric dams, irrigation diversion dams, and commercial fishing, and a shift was made to hatchery production. Today hatchery-raised salmon make up 80 percent of the total harvest in the Columbia Basin.

Current Conditions

The Okanogan Watershed currently supports anadromous runs of summer chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*Oncorhynchus nerka*), and steelhead trout (*Oncorhyncus mykiss*). There are 6 nonanadromous salmonids in the basin, and 24 species of nonsalmonids. See Appendix C for a species list.

ESA Listed Species

The Okanogan summer chinook stock is listed as Depressed based on a short-term severe decline in escapement. The Okanogan sockeye stock is listed as Healthy based on escapement. The Methow/Okanogan summer steelhead stock is listed as Depressed based on chronically low numbers (WDF and WDW, 1993).

Upper Columbia River steelhead trout and Upper Columbia River spring chinook salmon were listed as Endangered under the Endangered Species Act in August 1997 and March 1999, respectively. The steelhead listing includes both wild and hatchery stocks. The Okanogan Basin was not included as critical habitat for listed spring chinook because the species was extirpated at the time of listing. Bull trout were listed as Threatened in 1998. Westslope cutthroat trout were recently judged to be not warranted for listing. See Appendix D for excerpts of the ESA determinations.

Spring Chinook

Spring chinook have been extirpated from the Okanogan Subbasin. Suitable habitat for spring chinook exists above Enloe Dam and possibly in Salmon and Omak creeks. Historical records indicate spring chinook in Salmon Creek prior to 1906 (Craig & Suomela, 1941), tributaries upstream of Lake Osoyoos (Chapman, et al., 1994), and possibly in Omak and Similkameen Creeks (Fulton, 1968; Craig & Suomela, 1941). There is no clear evidence that chinook passed the natural falls on the Similkameen River (NMFS, 1998). Chinook currently do not have access to upper Salmon Creek because the lower 4 miles are dewatered.

Historically, chinook in the Okanogan may have included the following life history types:

1. Spawn, rear, overwinter in Salmon Creek.
2. Spawn and rear in Salmon Creek, overwinter in mainstem Okanogan River.
3. Spawn, rear in tributaries above Lake Osoyoos; overwinter in the lake.
4. Spawn, rear, overwinter in mainstem Okanogan above Lake Osoyoos.
5. Spawn, rear, and overwinter in Omak Creek.

In 2001, the USFWS Winthrop Hatchery released Carson stock spring chinook smolts and fry into Omak Creek.

Steelhead Trout

The historical record for steelhead trout in the Okanogan Basin is incomplete (Mullan, et al., 1992), but it is likely that very few ever used the Okanogan River. Salmon Creek, Omak Creek, and the Similkameen River supported small runs, but these were eliminated or reduced by passage barriers (NMFS, 1998). Few wild steelhead currently spawn successfully in the Okanogan Basin because many of the tributaries with spawning habitat are dewatered during the summer months. Furthermore, elevated temperatures and sedimentation in the Okanogan River limit quality and quantity of cold water refugia.

In the spring of 2001, Heather Barlett, WDFW fisheries biologist, and Chris Fisher, CTCR fisheries biologist, observed 2 steelhead redds in Bonaparte Creek and witnessed a steelhead spawning in Tonasket Creek. Whether or not the environmental conditions of Bonaparte Creek remained conducive for steelhead this year is unknown, however, Tonasket Creek is dry (Fisher, 2001).

The river is primarily used as a migration corridor to clearer, colder tributaries. Current habitat conditions in the migration corridor are poor for most if not all history types.

Five life history types are identified:

1. Spawn, rear and overwinter in Salmon Creek, outmigrate in spring.
2. Spawn and rear in Salmon Creek, overwinter in Okanogan River; outmigrate in spring.
3. Spawn and rear in Okanogan River and tributaries upstream of Lake Osoyoos, overwinter in the lake, and outmigrate in spring.
4. Spawn, rear, and overwinter in Omak Creek, outmigrate in spring.
5. Spawn and rear in Omak Creek, overwinter in Okanogan River, outmigrate in spring.

In the early 1960s, the Washington State Department of Game (now WDFW) began the steelhead hatchery program. This resulted in over-harvests of wild steelhead in mixed stock fisheries (Douglas, Chelan, and Grant PUDs, 1998). By the 1980s, it was standard practice to clip the adipose fin on hatchery stock, in order to distinguish the two populations and spare the wild steelhead. Table 17 summarizes steelhead sport fishery harvest from 1965 – 1994.

Table 17: US Sport Fishery Harvest of Adult Summer Steelhead Trout in the Okanogan Basin, 1965 – 1994 (Streamnet, 2001).

Stream Name	From Mile	Production	Begin Date	End Date	No.
Okanogan River	**0 - 77.2**	Hatchery	5/1/86	4/30/87	706
		Hatchery	5/1/87	4/30/88	159
		Hatchery	5/1/88	4/30/89	131
		Hatchery	5/1/89	4/30/90	317
		Hatchery	5/1/90	4/30/91	78
		Hatchery	5/1/91	4/30/92	489
		Hatchery	5/1/92	4/30/93	516
		Hatchery	5/1/93	4/30/94	107
		Mixed	5/1/65	4/30/66	20
		Mixed	5/1/66	4/30/67	129
		Mixed	5/1/67	4/30/68	10
		Mixed	5/1/68	4/30/69	22
		Mixed	5/1/69	4/30/70	6
		Mixed	5/1/70	4/30/71	31
		Mixed	5/1/71	4/30/72	66
		Mixed	5/1/72	4/30/73	12
		Mixed	5/1/73	4/30/74	6

Stream Name	From Mile	Production	Begin Date	End Date	No.
		Mixed	5/1/74	4/30/75	2
		Mixed	5/1/75	4/30/76	2
		Mixed	5/1/76	4/30/77	8
		Mixed	5/1/77	4/30/78	9
		Mixed	5/1/78	4/30/79	4
		Mixed	5/1/79	4/30/80	10
		Mixed	5/1/80	4/30/81	7
		Mixed	5/1/81	4/30/82	2
		Mixed	5/1/82	4/30/83	6
		Mixed	5/1/83	4/30/84	34
		Mixed	5/1/84	4/30/85	397
		Mixed	5/1/85	4/30/86	1193
		Natural	5/1/86	4/30/87	336
		Natural	5/1/87	4/30/88	2
		Natural	5/1/88	4/30/89	0
		Natural	5/1/89	4/30/90	0
		Natural	5/1/90	4/30/91	0
		Natural	5/1/91	4/30/92	4
		Natural	5/1/92	4/30/93	26
		Natural	5/1/93	4/30/94	0
Similkameen River	**0 - 27.8**	Hatchery	5/1/86	4/30/87	314
		Hatchery	5/1/87	4/30/88	72
		Hatchery	5/1/88	4/30/89	128
		Hatchery	5/1/89	4/30/90	164
		Hatchery	5/1/90	4/30/91	139
		Hatchery	5/1/91	4/30/92	447
		Hatchery	5/1/92	4/30/93	256
		Hatchery	5/1/93	4/30/94	76
		Mixed	5/1/81	4/30/82	10
		Mixed	5/1/82	4/30/83	13
		Mixed	5/1/83	4/30/84	17
		Mixed	5/1/84	4/30/85	339
		Mixed	5/1/85	4/30/86	746
		Natural	5/1/86	4/30/87	40
		Natural	5/1/87	4/30/88	0
		Natural	5/1/88	4/30/89	0
		Natural	5/1/89	4/30/90	0
		Natural	5/1/90	4/30/91	0
		Natural	5/1/91	4/30/92	0
		Natural	5/1/92	4/30/93	11
		Natural	5/1/93	4/30/94	0

Summer Chinook

The summer chinook run has declined slightly in the Okanogan River over the last 20 years, and has increased slightly in the Similkameen River (Chapman et al., 1994). The increase in the Similkameen population is at least partially due to the presence of the hatchery there, built in 1989. Summer chinook are managed for natural production and spawn in limited areas between Zosel Dam and Malott in the mainstem Okanogan River. In the Similkameen River, they spawn from Enloe Dam downstream to Driscoll Island. Many juveniles rear in the mid-Columbia impoundments after spending 1 to 4 months in the Okanogan. Table 18 lists summer chinook spawning survey results, and Table 19 lists redd count survey results.

Table 18: Spawner Counts for Summer Chinook Salmon in the Okanogan River (Mile 0 to Mile 81.9) 1977 - using Fish per Mile; estimation method unknown (Streamnet, 2001).

Begin Date	End Date	N
1/1/77	12/31/77	24
1/1/78	12/31/78	29
1/1/79	12/31/79	19
1/1/80	12/31/80	18
1/1/81	12/31/81	11
1/1/82	12/31/82	5
1/1/83	12/31/83	6
1/1/84	12/31/84	33
1/1/85	12/31/85	28
1/1/86	12/31/86	31
1/1/87	12/31/87	18
1/1/88	12/31/88	14
1/1/89	12/31/89	25
1/1/90	12/31/90	10
1/1/91	12/31/91	7

Table 19: Redd Counts for Summer Chinook Salmon in the Okanogan River (Mile 0 to Mile 77.2) and Similkameen River (Mile 0 to Mile 27.8) 1956-1996 (Streamnet, 2001).

Stream Name	Begin Date	End Date	No.
Okanogan River	1-Jan-56	31-Dec-56	37
	1-Jan-57	31-Dec-57	53
	1-Jan-58	31-Dec-58	94
	1-Jan-59	31-Dec-59	50
	1-Jan-60	31-Dec-60	29
	1-Jan-63	31-Dec-63	9
	1-Jan-64	31-Dec-64	112
	1-Jan-65	31-Dec-65	109
	1-Jan-66	31-Dec-66	389
	1-Jan-67	31-Dec-67	149
	1-Jan-68	31-Dec-68	232
	1-Jan-69	31-Dec-69	103

Stream Name	Begin Date	End Date	No.
	1-Jan-70	31-Dec-70	656
	1-Jan-71	31-Dec-71	310
	1-Jan-72	31-Dec-72	182
	1-Jan-73	31-Dec-73	138
	1-Jan-74	31-Dec-74	112
	1-Jan-75	31-Dec-75	273
	1-Jan-76	31-Dec-76	107
	1-Jan-77	31-Dec-77	276
	1-Jan-78	31-Dec-78	195
	1-Jan-79	31-Dec-79	173
	1-Jan-80	31-Dec-80	118
	1-Jan-81	31-Dec-81	55
	1-Jan-82	31-Dec-82	23
	1-Jan-83	31-Dec-83	36
	1-Jan-84	31-Dec-84	235
	1-Jan-85	31-Dec-85	138
	1-Jan-86	31-Dec-86	197
	1-Jan-87	31-Dec-87	201
	1-Jan-88	31-Dec-88	113
	1-Jan-89	31-Dec-89	134
	1-Jan-90	31-Dec-90	88
	1-Jan-91	31-Dec-91	55
	1-Jan-92	31-Dec-92	35
	1-Jan-93	31-Dec-93	144
	1-Jan-94	31-Dec-94	372
	1-Jan-95	31-Dec-95	260
	1-Jan-96	31-Dec-96	100
Similkameen River	1-Jan-57	31-Dec-57	30
	1-Jan-58	31-Dec-58	30
	1-Jan-59	31-Dec-59	31
	1-Jan-60	31-Dec-60	23
	1-Jan-63	31-Dec-63	17
	1-Jan-64	31-Dec-64	51
	1-Jan-65	31-Dec-65	67
	1-Jan-66	31-Dec-66	154
	1-Jan-67	31-Dec-67	77
	1-Jan-68	31-Dec-68	107
	1-Jan-69	31-Dec-69	83
	1-Jan-70	31-Dec-70	357
	1-Jan-71	31-Dec-71	210
	1-Jan-72	31-Dec-72	55
	1-Jan-73	31-Dec-73	64
	1-Jan-74	31-Dec-74	130
	1-Jan-75	31-Dec-75	201
	1-Jan-76	31-Dec-76	184
	1-Jan-77	31-Dec-77	139

Stream Name	Begin Date	End Date	No.
	1-Jan-78	31-Dec-78	268
	1-Jan-79	31-Dec-79	138
	1-Jan-80	31-Dec-80	172
	1-Jan-81	31-Dec-81	121
	1-Jan-82	31-Dec-82	59
	1-Jan-83	31-Dec-83	57
	1-Jan-84	31-Dec-84	301
	1-Jan-85	31-Dec-85	309
	1-Jan-86	31-Dec-86	300
	1-Jan-87	31-Dec-87	164
	1-Jan-88	31-Dec-88	191
	1-Jan-89	31-Dec-89	221
	1-Jan-90	31-Dec-90	94
	1-Jan-91	31-Dec-91	68
	1-Jan-92	31-Dec-92	48
	1-Jan-93	31-Dec-93	152
	1-Jan-94	31-Dec-94	463
	1-Jan-95	31-Dec-95	337
	1-Jan-96	31-Dec-96	252

Sockeye Salmon

The Okanogan River sockeye run is one of two remaining major sockeye runs in the lower 48 states. The Wenatchee River supports the other run. Lake Osoyoos is the primary rearing area for sockeye salmon in the Okanogan Basin. The lake is eutrophic and the good food supply produces good-sized smolts. Run strength is variable, ranging from a low of 1,662 in 1994 to a high of 127,857 in 1966, measured at Wells Dam. The 10-year average from 1986 to 95 is 28,460. Sockeye salmon spawn in the fall in an 4.97-mi reach of the river upstream of Osoyoos Lake (Hagen and Grette, 1994).

Upstream migration of adult sockeye to Lake Osoyoos is sometimes delayed by high water temperatures in the lower Okanogan River during July and August (Pratt, 1991). Schools of adult sockeye will stage at the mouth of the river to wait for a drop in water temperatures, which is often brought on by an upstream rain event.

Sockeye life history types include:

1. Spawn in Okanogan River downstream of McIntyre Dam, rear to a subyearling stage in Lake Osoyoos, outmitgrate in spring.
2. Spawn in Okanogan River upstream of McIntyre Dam, rear to a subyearling stage in Lake Osoyoos, outmigrate in spring.
3. Spawn in Okanogan River below McIntyre Dam, rear to a subyearling or yearling stage in Okanogan River downstream of Lake Osoyoos, outmigrate in spring.
4. Spawn in lower Similkameen River, rear to a subyearling stage in Okanogan River downstream of Lake Osoyoos, outmigrate in spring.

According to Fulton (1970), sockeye historically spawned in Palmer Lake and Sinlahekin Creek. Table 20 lists sockeye spawning survey data from 1956 to 1988.

Table 20: Spawner Counts of Sockeye Salmon in the Okanogan River (Mile 0 to Mile 81.9) 1956 – 1966; 1977 – 1988 (Streamnet, 2001).

Begin Date	End Date	N
1/1/56	12/31/56	39,256
1/1/57	12/31/57	25,350
1/1/58	12/31/58	31,035
1/1/59	12/31/59	40,650
1/1/60	12/31/60	8,600
1/1/61	12/31/61	2,440
1/1/65	12/31/65	4,970
1/1/66	12/31/66	24,166
1/1/77	12/31/77	2020
1/1/78	12/31/78	620
1/1/79	12/31/79	2170
1/1/80	12/31/80	2270
1/1/81	12/31/81	2320
1/1/82	12/31/82	1320
1/1/83	12/31/83	1970
1/1/84	12/31/84	5550
1/1/85	12/31/85	4100
1/1/86	12/31/86	2490
1/1/87	12/31/87	3110
1/1/88	12/31/88	7580
1/1/89	12/31/89	1230
1/1/90	12/31/90	700
1/1/91	12/31/91	2080

Bull Trout

Salmon Creek and Loup Loup Creek historically supported bull trout populations (*Salvelinus confluentus).* The introduction of brook trout and resulting hybridization of the two species has resulted in the extinction of bull trout in the Okanogan River Basin (NMFS, 1998).

Inland Species: Residents, Fluvials, and Adfluvials

Important inland species include mountain whitefish (*Prosopium williamsoni*), rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*), and eastern brook trout (*Salvelinus fontinalis*).

Rainbow Trout

Rainbow trout are the freshwater variety of steelhead trout (*O. mykiss*). They are present in Salmon Creek, Omak Creek, Toats Coulee, Sinlahekin Creek, Bonaparte Creek, and

Tonasket Creek, as well as other smaller tributaries. They appear to have one life history pattern: to spawn and rear in upper tributaries. The population size and distribution of rainbow trout in these streams is not known (NMFS, 1998).

Westslope Cutthroat Trout

The status of westslope cutthroat in the basin is unknown. They are present in the North Fork Salmon Creek subbasin, the Sinlahekin headwaters, and in numerous alpine lakes. In at least some locations, these waters were stocked with cutthroat in the past. They may not be native to the watershed.

Eastern Brook Trout

Eastern Brook trout are an introduced species that is present throughout the basin. In drainages where brook trout and bull trout are both present, they hybridize. Brook trout appear to be more tolerant to disturbed habitat conditions than bull trout.

Other species in the watershed include: bridgelip sucker (*Catostomus columbianus*), largescale sucker (*C. macrocheilus*), sculpin (*Cottus rhotheus* and *confusus*), chiselmouth (*Acrocheilus alutaceus*), peamouth (*Mylocheilus caurinus*), northern squawfish (*Ptychocheilus oregonensis*), longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*), and burbot (*Lota Lota*) (Pacific Rivers Council, 1996).

Several warm water species which have been introduced into the Okanogan Watershed include: largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomelui*), white crappie (*Pomoxis annularis*), bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), pumpkinseed sunfish (*Lepomis gibbosus*), black bullhead (*Ictalurus melas*), and walleye (*Stizostedion vitreum*). These species are favorites of many sports anglers. They also provide a large biomass of fish in the basin, and contribute to predation on juvenile salmon in the pools behind the mid-Columbia dams.

The recently released WDFW Wild Salmonid Policy Draft Environmental Impact Statement proposes to restore wild salmonid runs to historical habitats blocked by dams and diversion ditches. Nearly 3,000 miles of salmon and steelhead spawning streams in Washington State are currently inaccessible by fish (WDFW, 1997).

Table 21 displays a summary of salmonid distribution in the Okanogan Basin.

Table 21: Fish Distribution in the Okanogan Basin (Streamnet, 2001).

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Sockeye	Canadian mainstem	Water management/ high flows occasionally allow fish to pass above Lake Osoyoos. Occasional fish passage also occurs upstream of McIntyre Dam, 12.5 miles upstream of L. Osoyoos. End of current distribution is Okanogan Falls, approximately 12 miles upstream of McIntyre Dam.	Presumed distribution equivalent to known distribution.	Okanogan Falls represents historic upstream distribution	Headwaters of Okanogan Lake--assuming fish passage above Okanogan Falls could be engineered.	(1) McIntyre Dam, 12.5 miles upstream of L. Osoyoos [partial barrier some years, complete block in others], artificial. (2) Okanogan Falls (natural, complete block).	(1) Temperatures are too high for spawning near Driscoll Inlet (2) Currently, some spawning occurs above L. Osoyoos, in between Skaha Lake and McIntyre Dam in the main river channel during high flow years. It is not known if spawning occurs in tributaries of Skaha Lake, although they are thought to be too small. (3) No spawning occurs in the McLean Delta. (4) Kokanee in Skaha Lake spawn in Shingle Creek.	Howie Wright, Okanagan Nation Fisheries Commission. Supporting literature to review: BC Environment.

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Sockeye	Similkameen	Similkameen Delta	Presumed distribution to Enloe Dam on Similkameen (T. Scott harvested sockeye below dam in years past).	Likely similar to current distribution because no lake systems within Similkameen to support early life stages. Some sockeye stocked into Palmer Lake in the early 1900s (Chris F.); could sockeye have distributed into Palmer Lake? not known.	Palmer Lake and tributaries	Dam on the Similkameen	Mouth of Similkameen is used as a holding station for migrating sockeye. Refugia as cool water holding station may be critically important.	Tom Scott, Oroville-Tonasket Irrigation District; NMFS ESA status report; Douglas County PUD telemetry report; Dissertation of Jeff Fryer.
Sockeye	Other tributaries	Not known	Presumed use of all tributary deltas with cool groundwater contributions.	Not known, assumed equivalent to presumed distribution.	Rearing and refuge potential up to impassable barriers.	Barriers presumed equivalent to chinook barriers.	Olfactory clues may have been introduced into the Similkameen from Lake Osoyoos sockeye when they were initially stocked into Palmer Lake in the early 1900s (1910).	TAC group consensus

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Summer/ Fall Chinook	Canadian mainstem	To McIntyre Dam (Department of Fisheries and Ocean (DFO) 1-day float for sockeye in October identified ~4 dead Chinook below McIntyre Dam).	McIntyre Dam in good flow years	Headwaters of Okanogan Lake (historic fishery at Kettle Falls indicates passage into lake system).	Okanogan Lake and tributaries (with engineered fish passage)	(1) Zosel Dam (2) McIntyre Dam (3) Okanogan Falls	(1) Mission Creek tributary to Okanogan Lake could provide spawning habitat for chinook if they could get into the lake (H. Wright) (2) Some spawning may have occurred above Osoyoos Lake, as juveniles were captured just below Zosel Dam (outlet of Osoyoos L.) in 1997 smolt trapping efforts. These juveniles could also have been derived from spawning below the dam. Perhaps juvenile residents below.	Dept. of Fisheries and Oceans

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Summer/ Fall Chinook	Tonasket Creek	Known distribution not established with survey data for any life stage.	Presumed distribution to first passage barrier at ~RM 1.0. Habitat for refugia and rearing presumed; no spawning habitat available.	Unknown	Likely equivalent to historic distribution	Approximately 1 mile up from mouth a falls/cascade of large metal debris would restrict further fish passage upstream (N. Wells, T. Scott). Barrier status requires field confirmation.	(1) Dewatered during spawning season; dewatering due to natural conditions and withdrawals. (2) CREP map says 1 mile distance up from mouth. (3) Likely juvenile rearing habitat only (TAC consensus). (4) Water quality limited (temperature, sediment C. Fisher). No summers/fall adults seen in mouth/delta surveys by Colville Tribe (C. Fisher). Rearing not observed in summer surveys (C. Fisher). (5) Limited potential use of this habitat supports priority screening of restoration projects (S. Higby).	Tom Scott, Nance Wells, C. Fisher,
Summer/ Fall Chinook	Similkameen	Enloe Dam	Enloe Dam--same as current distribution.	Likely extensive use up to natural barriers.	Unknown	Enloe Dam	(1) Spawning occurs up to Enloe Dam	
Summer/ Fall Chinook	Bonaparte Creek	Unknown	Presumed rearing and refugia at mouth; no spawning.	Unknown	Unknown	(1) Flow likely restricts spawning and migration (C. Fisher). (2) Falls at ~ RM 1.0	(1) Flow likely restricts spawning and migration (C. Fisher) (2) Confirmation helpful (J. Fisher)	C. Fisher

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Summer/ Fall Chinook	Aeneas Creek	Unknown	Presumed juvenile rearing and refugia from mouth to ~ RM 0.5	To falls at ~ RM 1.25	Unknown	(1) Highway 7 barrier (box culvert) ~ ½ mile upstream (2) Falls ~ ¾ mile upstream of culvert	(1) Good water quality for rearing--some of the best of the tribs (C. Iten) (2) Probably flow limited (C. Fisher)	C. Fisher/C. Iten
Summer/ Fall Chinook	Omak Creek	Known rearing to ~ RM 0.5 (C. Fisher)	Presumed limit of distribution equivalent to known; needs confirmation.	Historic evidence of Spring Chinook (Chapman et al. 1941)	Likely equivalent to historic distribution	no known barriers		Chapman et al., 1941
Summer/ Fall Chinook	Salmon Creek	Unknown 1/2 mile from mouth?	Presumed use of mainstem to confluence of 3 forks for rearing under high flow years ? Presumed use of delta for rearing to RM ~ 0.5?	Historic use by spring chinook to confluence of the west and south forks. Presumed use by fall/summer chinook to confluence of all three forks.	Unknown, limited likely by flow and prohibitive gradients upstream.	(1) North Fork Barrier = gradient >10% (2) West Fork barrier at ~ ¼ to ½ mile from Conconully Lake	Uncertain if spring chinook could have used system at all (info from affidavits, Mullen et al., 1992 case).	K. Williams
Summer/Fall Chinook	Loup-Loup	Unknown	Presumed rearing to ~ RM 1/8	Unknown	Unknown	(1) Old Highway 97 ~ 1/8 river mile, and at Mallott (double culverts)		W. Trihey and C. Fisher
Bull Trout	Canadian waters	Unknown; not demonstrated	Unknown	Unknown	Unknown	no known barriers?		J. Olyslager

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Bull Trout	Ruby Creek	not demonstrated - USFS reports	Unknown	lower extent at Ruby Creek up to inlet of Conconnully	Likely equivalent to historic distribution	no known barriers?		W. Trihey & C. Fisher
Bull Trout	Salmon Creek	not demonstrated - USFS reports	presumed absent	North Fork: between headwater falls and falls on Pelican Creek. West Fork: to Salmon Creek Falls. South fork: to barrier before Forest Service Property	Likely equivalent to historic distribution	(1) Barrier on West Fork (Salmon Creek falls). (2) South Fork Barrier before F. Service Property		N. Wells, C. Fisher
Bull Trout	Loup-Loup	not demonstrated		Falls was historic lower extent (near where K. Williams lives); presumed historic distribution to headwaters	Likely equivalent to historic distribution	no known barriers?	Rainbow and brook trout introductions may be, in part, responsible for loss (?) of bull trout.	K. Williams
Steelhead	Canadian waters	Angler survey in May: Hatchery Steelhead (tagged) just above Osoyoos Lake.	Presumed distribution to McIntyre Dam, in between L. Osoyoos and Skaha Lake.	Historic distribution to headwaters of Okanogan Lake.	Likely equivalent to historic distribution	no known barriers?	Uncertain if tagged steelhead was a resident fish or migrant. No data on specific life stages supported in Canadian waters.	H. Wright

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Steelhead	Tonasket	Distribution to below large metal debris falls (Dave B.). Spawning not supported currently. Rearing and refugia at the mouth	Presumed equivalent to known distribution.	Unknown. Historically probably not able to support spawning	Likely equivalent to historic distribution	Approximately 1 mile up from mouth a falls/cascade of large metal debris may restrict further fish passage upstream (N. Wells, T. Scott).	Barrier status requires field confirmation.	Dave B.
Steelhead	Similkameen	Current distribution to Enloe dam	Presumed distribution equivalent to known distribution.	Unknown. Historically likely to prohibitive gradients.	Likely equivalent to historic distribution	no known barriers?		TAC group consensus
Steelhead	Bonaparte	to first barrier at falls (river mile 1.0), possible ascension above at right flow	Presumed distribution equivalent to known distribution.	Historic distribution is the same as current and presumed distribution	Unknown available habitat above falls.	(1) falls at RM 1.0.	(1) no spawning surveys have been conducted in the subbasin. (2) good water quality, could support rearing if the steelhead spawned (T. Neslen)	C. Fisher,
Steelhead	Antoine Creek	Currently not used.	Presumed distribution equivalent to known distribution.	Historic use likely to ~ RM 3.5 (N. Wells)	Unknown, limited likely by flow and prohibitive gradients upstream.		(1) low flows from natural conditions and private withdrawals limit the current use of the subbasin (N. Wells).	N. Wells
Steelhead	Aeneas Creek	Current distribution to Highway 7 (bridge at about RM 0.5)	Same as current distribution	To ~ RM 1.25, at falls	Unknown distance above natural falls	(1) Highway 7 barrier (box Culvert) ~ ½ mile upstream (2) Falls ~ ¾ mile upstream of culvert	(1) Good water quality for rearing--some of the best of the tribs (C. Iten) (2) Probably flow limited (C. Fisher)	C. Fisher and N. Wells

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Steelhead	Siwash Creek	Currently not used.	Presumed distribution equivalent to known distribution.	Historic distribution likely to about RM 0.5	Unknown, likely to where flow and gradients cumulatively prohibitive.	no known barriers?	Dewatering likely restricts current use.	
Steelhead	Chiliwist Creek	Unknown	Presumed to ~ RM 0.5.	About the same	Unknown, likely to where flow and gradients cumulatively prohibitive.	(1) natural gradient on old 97 blocks access through orchards. (2) Culvert at ~ RM 0.5. (3) Channelization in lower reach		T. Neslen, Okanogan Cons. Dist.
Steelhead	Omak Creek	Distribution to mouth of Trail Creek (RM 17) ; Lower 1 mile of Trail accessible (mainstem Omak not possible above).	Presumed distribution equivalent to known distribution. Presumed distribution to first tributary upstream of Mission Falls.	Same as current distribution	Same as current distribution	No barriers to about river mile 17 (C. Fisher).	Tagged fish recovered for upstream (about river mile 10)	
Steelhead	Salmon Creek	Known use to 1 mile from confluence with Okanogan mainstem; (telemetry study, Bickford et al.- PUD, 1999 siting)	Possible presumed current use in high water years only to Conconully	Same as spring chinook	Same as spring chinook	Same as Spring Chinook		

Salmonid Species	Subbasin	Current Known Upstream Distribution	Current Presumed Upstream Distribution	Historic Upstream Distribution (first natural barrier)	Potential Upstream Distribution (assumes no natural barriers)	Barriers	Comments	Sources
Steelhead	Loup-Loup	To first barrier in Mallott, about RM 1/8 mile (same as chinook)	Presumed equivalent to known distribution.	To falls by Ken Williams; need to confirm RM.	Unknown, likely to where flow and gradients cumulatively prohibitive.	(1) Old highway 97 ~ 1/8 river mile, and at Mallott (double culverts)		
Steelhead	Whitestone Creek	To river loop road, barriers = culverts	Presumed equivalent to known distribution.	unknown	Unknown, likely to where flow and gradients cumulatively prohibitive.		Highly channelized along Loomis Highway	
Steelhead	Tunk Creek	About ½ mile from mouth to McAllister Falls	Presumed equivalent to known distribution.	McAllister Falls	Unknown, likely to where flow and gradients cumulatively prohibitive.			

Wildlife

The Okanogan River watershed supports a wide range of wildlife, as its varied topography and vegetation would suggest. Plant communities in the basin range from the sub-alpine in the high elevations of the Tiffany Mountain area and Pasayten Wilderness to shrub-steppe in the lower elevations along the Similkameen and Okanogan rivers. See Appendix E for a complete list of wildlife species in the basin.

Humans have impacted wildlife since before recorded history. Records begin with European exploration and settlement. Activities of the early European settlers that impacted wildlife and wildlife habitat included mining, cattle drives, fur trapping, agriculture, and orcharding, fire suppression, and forest management activities. Farms and orchards fragmented wildlife habitats and hindered movement of many species.

Wildlife species listed under the Endangered Species Act that are present or may be present in the Okanogan Basin are listed in Table 22. Both federal and state status are listed. Species that are included on the Washington State list but not listed on the Endangered Species Act are listed in Appendix F.

Table 22: Federal and State Listed Wildlife Species Present or Potentially Present in the Okanogan Basin.

Species	Federal Listing	State listing
Grizzly bear	Threatened	Endangered
Grey Wolf	Endangered	Endangered
Wolverine	Concern	Concern
Lynx	Threatened	Threatened
Fisher	Concern	Endangered
California Bighorn sheep	Concern	
Western gray squirrel	Concern	Threatened
Long-eared myotis	Concern	Monitor
Fringed myotis	Concern	Monitor
Long-legged myotis	Concern	Monitor
Yuma myotis	Concern	Monitor
Small-footed myotis	Concern	Monitor
Pacific Townsend's big-eared bat	Concern	Concern
Bald Eagle	Threatened	Threatened
Northern goshawk	Concern	Concern
Ferruginous hawk	Concern	Threatened
Peregrine Falcon	Concern	Endangered
Burrowing owl	Concern	Concern
Sharp-tailed grouse	Concern	Threatened
Harlequin duck	Concern	
Loggerhead shrike	Concern	Concern
Black Tern	Concern	Monitor
Tailed frog	Concern	Monitor
Columbia spotted frog	Concern	Concern
Oregon Spotted frog	Candidate	Endangered
Western toad	Concern	Concern

Species	Federal Listing	State listing
Sagebrush lizard	Concern	
Giant Columbia spire snail	Concern	Concern
Sage grouse	Concern	
Willow flycatcher	Concern	
White-breasted nuthatch	Concern	Concern

The CTCR's main concern for this subbasin and other areas on the Reservation is to maintain viable populations of native and desired non-native species of wildlife, and their supporting habitats, while providing wildlife in sufficient numbers to meet cultural, subsistence, and recreational needs of the Colville Tribal members.

The WDFW maintains an active management program for species of special concern in the basin. Following are discussions of these species and the WDFW management activities.

Forest Carnivores and other Fur-bearers

Fur bearing animals were extensively trapped in the early 1800s and by the turn of the century were practically nonexistent. Reintroduction and protective management has restored harvestable populations of some of these animals (Pacific Northwest River Basins Commission, 1977). The WDFW conducts snow tracking surveys to assess populations of lynx, wolverine, fisher, and other forest carnivores. Lynx, wolverine, and fisher are state and federally listed species. Several of these populations declined dramatically as a result of trapping in the early 1800s. Later, timber harvest and other resource activities further impacted remaining populations.

The CTCR participates in ongoing cooperative studies of forest carnivores with both WFWD and Forest Service including the lynx tracking study and a proposed marten habitat and prey base diet suitability study for the Okanogan Highland area. As previously stated, all native and desired non-native species are of concern to the CTCR. Forest carnivores, specifically: Grizzly bear, black bear, wolf, coyote, fox, cougar, lynx, bobcat, wolverine, fisher, marten, badger, mink, and weasel, are all very important in spiritual, cultural, economic, and ecological ways. It is a priority to the tribes that the predators continue to persevere here in a biologically balanced way. These animals are of high regard ceremonially as are the furbearers, which includes otter, beaver, muskrat, raccoon, and rabbits. The status of these animals in remains unknown.

Mule Deer

Mule deer populations have varied dramatically throughout recorded history of the region. In the 1800s mule deer populations were reported to be extremely low (OWSAC, 2000). In the 1900s, deer populations fluctuated widely, with historic highs in the 1950s and 1960s. Population lows are due to a number of factors, including severe weather conditions, overused winter range, and hunting pressure. Severe winter weather conditions have significantly reduced mule deer populations since 1992. The winter of 1996-97 was especially hard on the local herds. "Qualitative observations from land managers, biologists, and long time residents, as well as harvest figures, suggest the populations may be half of what it was in the mid 1980s and early 1990s" (OWSAC, 2000). A shorter season and reduced number of hunters in 1997 along with easier overwintering conditions during the 1997-98 winter has been beneficial to the herds (OWSAC, 2000).

"Deer damage is a chronic problem in the Omak district. During severe winters, deer are often forced onto low elevation private property in close proximity to human development. At such times, damage to orchards, haystacks, and landscaping can be significant" (OWSAC, 2000).

The WDFW conducts annual mule deer and white-tail deer population surveys, and manages its wildlife areas for winter mule deer range. The USFS and WDNR also manage portions of their lands for winter deer range.

The CTCR is a major financial contributor to, and is involved in, an ongoing long-term mule deer study with WFWD, Chelan Co. PUD, Forest Service, Inland NW Wildlife Council, WSU, UW, and UI. CTCR is actively monitoring habitat, limiting factors and population trends. CTCR performs annual aerial surveys, regulates tribal hunting seasons and manages hunter check stations. Mule deer on the reservation are suffering long –term declines attributed to habitat changes, habitat fragmentation, severe weather conditions and overgrazing. Data from CTCR aerial trend counts indicate severe declines in both mule deer and white-tail populations. (Sanpoil Subbasin Summary). Mule deer are important for cultural and subsistence reasons.

Elk

Elk populations in Eastern Washington are strong and relatively stable due primarily to the large amount of elk winter range controlled by WDFW. Data compiled by CTCR indicate that elk numbers appear to be declining reservation-wide while the population is becoming more distributed. The Omak Creek drainage provides good elk habitat and hunter report records verify that elk are being harvested in that area. CTCR collect information on herd size and structure, regulate tribal member hunting seasons, and utilize check stations. Elk are extremely important to the tribes for subsistence and ceremonial purposes.

Bighorn sheep

Prior to 1900, bighorn sheep roamed over much of the area, but by the turn of the century had all but disappeared. The last native bighorn sheep was killed near Loomis about 1915 (Pacific Northwest River Basins Commission, 1977). They were reintroduced to the basin starting in 1957. (WDFW, 1995). Currently The WDFW is transplanting bighorn sheep to the basin. There are isolated herds of bighorn sheep on both the North Half and on the reservation portion of the Okanogan Subbasin. The CTCR does manage a tribal member bighorn sheep hunt with a drawing for one tag per year. Current information regarding total numbers and structure of the Omak Reserve herd is incomplete.

Small Mammals

Small mammals of particular interest to the Tribes in the Okanogan drainage area, are the myotis and pallid bats, the western gray squirrel, and Merriam's shrew. Tribal management efforts extend to supporting and enhancing existing and potential habitat through reduced fragmentation of wildlife habitat necessary to provide for the life requisites of viable populations of terrestrial, avian, and aquatic species (CTCR, 1999). The Tribes goal of increasing numbers of lagomorphs and small mammals to help support recovery of the lynx may in turn provide a prey diet base for coyote and cougar. This could help to lessen pressure on deer and elk populations.

Raptors

There are currently 21 known active bald eagle nesting territories on the Colville Reservation (Bald Eagle Survey 2000). Nesting activity appears to be expanding due to an increase in breeding adults produced in previous years and presence of abundant potential habitat. Nests are checked twice annually: once in April for occupancy and again in July for production (Annual Report 2000.) The CTCR was an active participant in a 5 year peregrine falcon reintroduction project, concluded in 1997 (CTCR, 1998). The hope is that the falcons have dispersed throughout the reservation. Additionally, golden eagle, goshawk, ferruginous hawk, merlin, prairie falcon, and flammulated owl, as well as other birds of prey, are currently or have been known to inhabit the Okanogan Subbasin area of the reservation. The CRCT holds as a guideline the protection of raptor nest sites that are currently being used, as well as important roost trees and associated habitat in the area surrounding the nest trees (CTCR, 1999). Status of all raptors is, other than bald eagles, is virtually unknown. Raptors are particularly important to the Tribes culturally and spiritually.

Columbia Sharp-tailed Grouse

Columbian sharp-tailed grouse numbers have drastically declined in Washington over the past 100 years, and they are now a federally and state listed species. The breeding population of sharp-tailed grouse in Washington is currently estimated at 380. Shrub-steppe and riparian habitat are critical habitat for sharp-tailed grouse, and both have been heavily manipulated in the basin (OWSAC, 2000). The USFWS recently issued a 90-day Finding on a petition to list sharp-tailed grouse as Threatened under the ES (USFWS, 1999).

According to early explorers sharp-tails used to be plentiful in Eastern Washington. A total of 112 sharp-tailed grouse leks (courtship areas) were documented between 1954 and 1994. Lek counts are used to estimate population size and stability. The number of males per lek and active leks also indicate stability of the population. Males per lek declined from 13 in 1954 to 5 in 1994. In Douglas County from 1954 to 1994, 46 percent of active leks disappeared, 65 percent disappeared in Okanogan County, and 61 percent disappeared in Lincoln County.

Several environmental and habitat changes appear to have led to improved sage grouse and sharp-tailed grouse populations. Sharp-tails are present in Douglas, Lincoln, and Okanogan counties. Areas supporting the most sharp-tails include West Foster Creek, East Foster Creek, Cold Springs Basin, and Dyer Hill in Douglas County; Swanson Lakes Wildlife Area in Lincoln County; and the Tunk Valley and Chesaw Units of the Scotch Creek Wildlife Area in the Okanogan Basin. Ziegler (1979) documented a 51 percent decline in waterbirch and aspen from 1945 to 1977 in Johnson Creek. Waterbirch buds are the primary food of sharp-tailed grouse during the winter (Hays et al., 1988). In addition, 13 percent of landowners contacted in Okanogan County were planning to remove waterbirch or aspen (OWSAC, 2000). Much winter habitat in Okanogan County has been lost to residential development. One lek was destroyed by a recreational subdivision (OWSAC, 2000). Hofmann and Dobler (1988a) also reported the loss of waterbirch in two locations in Okanogan County in less than three months of observation. Sharp-tails no longer used these areas after waterbirch was removed (Hofmann and Dobler, 1988a).

WDFW has an active survey and management program for sharp-tailed grouse due to their state-listed status, and the Okanogan population is considered to be one of the last strongholds for the species. There is an augmentation program underway. Populations and habitat are surveyed annually. Birds are transplanted from elsewhere, research is underway, and WDFW is pursuing land acquisition for habitat.

The CTCR is currently managing sharp-tailed grouse within the Reservation boundaries to eliminate habitat alteration, fragmentation, and human-caused events that put these populations at risk. The CTCR has recently begun a study of this species in coordination with Washington State University to address limiting factors and habitat restoration within the region.

Upland and Game Birds

There are numerous upland birds and small game animals in the Okanogan Basin. Most of these species are dependent upon the riparian zone along rivers and creeks.
Upland game bird populations increased in the early years of dry-land farming, which provided winter feed for the birds and fence rows for cover. More recently, bird populations have been negatively impacted by changes in crops, farming methods, grazing, and abandonment of upland dry-land farms. (Pacific Northwest River Basins Commission, 1977).

The CTCR reservation supports many species of upland and other game birds. The CTCR wildlife staff run annual grouse and dove counts, in cooperation with the USFWS. The Tribes provide an annual non-member game bird hunt. Dove numbers on the Okanogan route are down from the early 1990’s and chukar numbers are depressed as well (CTCR, 2001). Dove are particularly important in a cultural aspect. Tribal members engage in turkey and grouse hunting and all game birds hold economic, subsistence and cultural value for the tribal membership. Status of birds, other than doves and chukar, is unknown.

Waterfowl

The 1997-98 midwinter waterfowl inventory was completed by WDFW and U.S. Fish and Wildlife Service (USFWS). During the 1980s, ducks declined in the Pacific Flyway midwinter survey, from about 7,000,000 in the 1970s. Numbers increased from 5,473,691 in 1996-97 to 6,607,263 in 1997-98.

Principal waterfowl species of the Okanogan Basin include Canada goose, mallard, wood duck, common merganser, coot, teal, green-winged teal, American widgeon, common goldeneye, Barrow's goldeneye, ruddy, ring-necked duck, lesser scaup, and bufflehead. Less common species included northern pintail, shoveler, harlequin duck, redhead, canvasback, blue-winged teal, cinnamon teal, gadwall, and whistling swan.

The CTCR performs annual waterfowl surveys which have indicated that waterfowl numbers peaked on the Colville Reservation during the mid-80's and though numbers are still low by comparison, they seem to be slowly increasing (CTCR, 2001) Waterfowl are also part of the non-member hunt and are important not only economically but culturally as well.

Common Loon

Common loons have been nesting on the Twin Lakes, in the eastern portion of the reservation, for at least 20 years on record, though likely much longer historically. Two nesting sites are known and protected. The CTCR participates in an annual international loon banding program and actively protects and manages loon nesting sanctuaries, in conjunction with public education and tribal enforcement of no-wake zones. Large numbers of migratory loons do also utilize many other bodies of water on the reservation, potentially including the Okanogan drainage area. The CTCR have and will continue to demonstrate dedication to the protection of nesting and migratory loons.

Neotropical birds

Surveys for neotropical birds and their habitats have been done only in recent times on forested uplands. There is little or no existing data on which to base trends that might relate to watershed condition. Wild turkeys are being transplanted to the area to augment existing populations.

The CTCR is planning to conduct surveys to assess neotropical bird populations and their habitat. There is presently little data available to determine the limiting factors on neotropical birds.

Reptiles and Amphibians

Very little is currently known of the herptile (reptile and amphibian) in the Okanogan subbasin area. Sagebrush lizard and western toad, both federally listed, have been documented in this area. The CTCR Wildlife department acknowledges the need to survey and does plan collect that information and develop management objectives as resources allow.

Exotic Species

There are numerous introduced species in the basin. Many of these were introduced as game animals. The practice of stocking exotic wildlife for hunting ended in 1983

(OWSAC, 2000). Declines in pheasant and chukar populations since may be a result of this policy change as well as changes in habitat and weather conditions. Table 23 is a listing of the species introduced into the Okanogan River Watershed.

Table 23: Okanogan Subbasin Introduced Wildlife Species.

Species	When Introduced	Current Status/Remarks
California bighorn sheep	Native – reintroduced in 1957, 1970, and currently	Program to supplement native populations
Chukar	Unknown	Unknown
Hungarian partridge	Unknown	Unknown
Ring-necked pheasant	Unknown	Unknown
Turkey (Rio Grande subspecies)	1991 through 1995	Stable
California quail	Unknown	Unknown
Red fox	Unknown	Documented

Watershed Assessment

Numerous assessments have been completed by federal, state, tribal, and local agencies over the last several years. They are listed here, followed by a brief excerpt from each introduction, describing the contents.

USDI Bureau of Land Management and USDA Forest Service. 2000. The Interior Columbia Basin Ecosystem Management Project DRAFT.

This project was implemented to develop a scientifically sound and ecosystem-based strategy for management of eastside forests. The draft EIS focuses on critical needs at a broad scale: landscape health; aquatic habitat; terrestrial habitat; and human needs, products, and services. The management direction in the EIS describes desired outcomes, and defines a network of important areas from which to anchor fish and wildlife conservation and ecosystem restoration efforts.

USDA Forest Service. 1999. Antoine & Siwash Creeks Watershed Analysis Draft. Tonasket Ranger District, Okanogan National Forest, Okanogan, WA.

USDA Forest Service. 1999. Tonasket Creek Watershed Analysis Draft. Tonasket Ranger District, Okanogan National Forest, Okanogan, WA.

USDA Forest Service. 1998. Bonaparte Creek Watershed Analysis Draft. Tonasket Ranger District, Okanogan National Forest, Okanogan, WA.

USDA Forest Service. 1997. Salmon Creek Watershed Analysis Draft. Tonasket Ranger District, Okanogan National Forest, Okanogan, WA

Beginning in 1995, the Okanogan National Forest has conducted watershed analyses on all major drainages on the forest. These assessments document the existing condition of the resources, and recommend activities that would help to meet management direction pertaining to the watershed.

USDA Forest Service. 2000. Integrated Weed Management Environmental Assessment. Okanogan National Forest, Okanogan, WA.

This assessment documents the analysis and potential effects of implementing an integrated weed management program in the Okanogan National Forest. Current conditions and environmental consequences of the proposed alternative action plans are described.

National Marine Fisheries Service, et al. 1998. Aquatic Species and Habitat Assessment: Wenatchee, Entiat, Methow, and Okanogan Watersheds.

This document summarizes information on aquatic species and their habitats in the four major tributaries to the mid-Columbia River. The emphasis is on anadromous salmonids. The report is based on the knowledge of local parties, fisheries and aquatic scientists, and from historical and recent studies.

Washington Department of Ecology. 1995. Initial Watershed Assessment, Water Resource Inventory Area 49, Okanogan River Watershed. Open file Report 95-14. Prepared by Montgomery Water Group, Inc., Kirkland, WA.

This report is the product of a recent initiative by the WSDOE to assess the availability of ground and surface water for each watershed within Washington State. This initiative is part of a larger overall effort to make the water rights decision-making process more efficient. The watershed assessment process will not only reduce the time needed to make decisions, but also will allow WSDOE to make better informed decisions based on a more comprehensive understanding of each watershed. WSDOE also believes these reports will be useful to local governments for planning purposes.

The scope of this report was limited to a review of existing information. No new field work or data collection efforts were conducted. Numerous data exist providing information on the geology and groundwater resources of the Okanogan area. The information is primarily in the form of reports and maps by the United States Geological Survey (USGS), the State of Washington Department of Natural Resources (WDNR) and the State of Washington Department of Ecology (WSDOE). Other sources of data include master's theses performed in the area, water well logs on file with WSDOE, and miscellaneous data collected by various agencies. A complete list of the data reviewed for this report is contained in the bibliography.

Washington State Conservation Commission. Salmon, Steelhead, and Bull Trout Habitat Limiting Factors. Water Resources Inventory Area 49. Prepared by ENTRIX and Golder Associates, Inc. Due to be released in June 2001.

This document will assess the habitat conditions in the Okanogan Basin as they affect the capacity of the habitat to sustain naturally producing salmonid populations.

Confederated Tribes of the Colville Indian Reservation and Natural Resource Conservation Service. 1995. Omak Creek Restoration Plan. Okanogan County, Washington.

Confederated Tribes of the Colville Indian Reservation, Okanogan County, NRCS. 1995. Omak Creek Watershed Plan and Environmental Assessment. Okanogan, Washington.

During 1995 a watershed assessment was completed for Omak Creek. The assessment was prepared under the authority of the Watershed Protection and Flood Prevention Act (16U.S.C 1001-1008), known as Public Law 566 (PL 566). The plan was prepared by the CTCR, Natural Resources Conservation Service (NRCS) and the Bureau of Indian Affairs (BIA). The plan was formulated to achieve watershed improvement and to restore fish habitat for anadromous fish.

Colville Confederated Tribe. 1997. F. Phase I: Inventory and Analysis Reports. Okanogan County, WA.

Okanogan Conservation Districts and Okanogan Watershed Stakeholders' Advisory Committee. 2000. Okanogan Watershed Water Quality Management Plan. Okanogan, WA.

This document was developed to characterize the environments of the Okanogan River Watershed and recommend action items necessary to protect or improve water quality conditions. A water quality monitoring plan is outlined in this document, and was implemented in fall 2000.

Loomis State Forest Final Landscape Plan. 1996. Washington State Department of Natural Resources. Olympia.

Upper Columbia Salmon Recovery Board (UCSRB). 2001 A Strategy to Protect an Restore Salmonid Habitat in the upper Columbia Region. Discussion draft, July 12, 2001

This document outlines a proposed strategy to protect and restore salmonid habitat in the Upper Columbia Region. The intent of the document is to provide a technical foundation to set regional priorities for habitat protection and restoration, based on available information and the professional judgement of fisheries biologists familiar with the region. This report was developed by a Regional Technical Team (RTT), which was established by the Upper Columbia Salmon Recovery Board (UCSRB). Recommendations contained herein may be used by decision-makers to more effectively allocate resources to contribute to the recovery of salmonids listed under the federal Endangered Species Act (ESA). This report is an update to an initial document provided to the UCSRB (RTT 2000). It provides more detail than the previous reports on the types of habitat protection and restoration measures, and suggests means to incorporate various habitat and fish production assessments into an interim regional effectiveness-monitoring program. The RTT will release a companion report on assessment and effectiveness monitoring in early 2002.

Proposed Actions by Management Agencies

Appendix K lists projects proposed by the Confederated Tribes of the Colville Reservation.

A Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region

A Report to the Upper Columbia Salmon Recovery Board (USCRB) from the Upper Columbia Regional Technical Team (RTT)

This document outlines a proposed strategy to protect and restore salmonid habitat in the Upper Columbia Region. The intent of the document is to provide a technical foundation to set regional priorities for habitat protection and restoration, based on available information and the professional judgement of fisheries biologists familiar with the region.

The RTT considers this report to be iterative. New and more refined biological priorities could be developed when key policy directives are made, or when new biological data are gathered. The priorities suggested in this report are consistent with the July 2000 report released by the RTT. This version provides greater detail and suggests a more strategic approach for protection and restoration of habitat.

This document complements the Habitat Limiting Factors Analyses (HLFA) conducted by the Washington Conservation Commission. It uses the information in the completed HLFA reports (Entiat, Foster Creek/Moses Coulee, and Methow) and the draft HLFA reports (Wenatchee and Okanogan) to establish a common framework throughout the region, rather than on an individual WRIA basis.

Limiting Factors

Barriers to fish migration, elevated temperatures, and sedimentation are some of the primary limiting factor to anadromous fish reproductive success in the Okanogan Basin. The Okanogan River and most of the tributaries have human made barriers, including dams, culverts, and dewatered stream channels. High water temperatures in the mainstem Okanogan River limit fish reproduction and migration.

The CTCR is currently conducting a limiting factors analysis in conjunction with WSCC for the Okanogan Basin.

Artificial Production

There are four hatcheries that supply salmonids to the Okanogan Basin streams (Table 24). Wells Dam supplies steelhead and chinook. The Omak Hatchery produces rainbow trout, eastern brook trout, Lahontan cutthroat trout, and kokanee, all for the sports fishery. The CTCR runs a resident trout hatchery, from which they supply Lahontan cutthroat to Omak Lake. The CTCR also managed the Cassimer Bar Hatchery on the Columbia River to produce sockeye salmon, until 2001, when the Douglas PUD discontinued funding to that facility. There are several reasons for the decision to withdraw funding. The CTCR is currently considering management options, including using the facility to raise locally adapted steelhead for the basin.

Table 24: Hatcheries that Supply the Okanogan Basin.

Hatchery	Management Agency	Drainage	Fish
Omak Hatchery	WDFW	Omak	Trout, Kokanee
Similkameen Rearing Pond	WDFW	Similkameen	
Wells Dam Hatchery	WDFW	Columbia	Steelhead, chinook
CTCR trout hatchery	CTCR	Columbia (Chief Joseph Bar)	Trout

Artificial production in the basin for 2000 is outlined in Table 25. Projections for artificial production of steelhead in 2001 are displayed in Table 26. Artificial production from 1983 – 1998 is summarized in Table 27. See Appendix G for the Hatchery and Genetic Management Plan for Okanogan Subbasin production programs.

Table 25: Artificial production in the Okanogan Subbasin – year 2000 (Streamnet, 2000).

Agency	Species	Age	Size #/lb.	# Rls'd	Facility	Release Location	Comments
CTCR	Sockeye	1	56	21,557	Cassimer Bar	L. Osoyoos/ Okanogan River	100% left ventral clipped
WDFW	Summer Steelhead	1	6.2	68,580	Wells	Similkameen Rearing Pond	100% adipose clipped
WDFW	Summer Steelhead	1	6.2	76,070	Wells	Okanogan River	100% adipose clipped
				19,400	Wells	Omak Creek	100% adipose clipped
				10,395	Wells	Salmon Creek	100% adipose clipped
WDFW	Summer Chinook	1	9	293,064	Wells	Similkameen Rearing Pond/ Okanogan River	100% adipose clipped and coded wire tagged.
WDFW	Summer Chinook	0	70	85	WDFW	Okanogan River	Released by Brewster School District Unmarked
WDFW	Summer Chinook	0	80	196	WDFW	Similkameen Rearing Pond/ Okanogan River	Released by Oroville Elem. School in Similkameen River. Unmarked

Table 26: Projected Releases of Steelhead for 2001.

Stream Name	Projected Release
Omak Creek	20,000
Salmon Creek	15,000
Similkameen	50,000
Okanogan River	75,000
Total for all streams	160,000

In March 2001, 140,000 Carson stock spring chinook smolts were released into Omak Creek. These fish were the progeny of surplus returning adults at the USFWS hatchery in Winthrop, Washington.

An agreement between NMFS and CTCR on the use of Carson Stock spring chinook is included in Appendix O. There is an ongoing discussion about the use of out-of-basin stocks.

Table 27: Historic Hatchery Release Data for the Okanogan Basin, 1983 – 1998.

Stream Name	Species	Run	Release Year	Number Released
Bonaparte Creek	Chinook	Summer	1995	384
Bonaparte Creek	Sockeye		1995	30,100
			1996	30,000
			1998	30,228
Okanogan River	Chinook	Summer	1995	480
Okanogan River	Sockeye		1993	38,200
Okanogan River	Steelhead	Summer	1987	95,550
			1988	91,620
			1989	102,300
			1990	98,400
			1991	72,830
			1992	66,645
			1993	60,660
			1994	38,700
			1995	40,875
			1996	37,500
			1997	49,920
			1998	39,998
Omak Creek	Steelhead	Summer	1989	10,500
			1991	6,290

Stream Name	Species	Run	Release Year	Number Released
			1992	5,400
			1993	6,460
			1994	7,410
			1998	10,005
Palmer Creek	Sockeye	N/A	1995	100,100
Palmer Creek	Sockeye	N/A	1998	115,416
Similkameen River	Chinook	Fall	1994	828
			1996	466
Similkameen River	Chinook	Summer	1991	352,600
			1992	540,000
			1993	675,690
			1994	547,182
			1995	586,532
			1996	536,299
			1997	587,000
			1998	507,913
Similkameen River	Steelhead	Summer	1983	99,639
			1984	76,080
			1985	59,439
			1986	50,984
			1987	90,410
			1988	81,528
			1989	89,674
			1990	97,494
			1991	90,320
			1992	47,215
			1993	51,360
			1994	49,800
			1995	50,350
			1996	37,500
			1997	49,800
			1998	49,901

Existing and Past Efforts

Okanogan River Streambank Restoration

A streambank restoration demonstration project was completed in 1995 along 500 meters of highly erosive bank near Ellisforde. The restoration included bank sloping, rootwads, rock placement, and willow/cottonwood plantings. By 1997, much of this streambank restoration has failed in flood conditions due to inadequate size and placement of barbs (NRCS, 1994).

Okanogan River Floodplain Acquisition

The Washington Department of Fish and Wildlife has talked to landowners in the Okanogan floodplain between Riverside and Janis. This is the only intact riparian area along the Okanogan in the U.S. Landowners are interested in selling, but as yet the state does not have funds to make the purchase.

Okanogan River Sockeye Population

To address stabilizing and rebuilding the population of Okanogan River sockeye, an experimental re-introduction of sockeye salmon in Skaha Lake is proposed. This study would assess the potential risks (disease transfer, exotic species introduction, competition) and benefits (strengthening an indigenous stock, increased commercial, sport and tribal fisheries) of reintroducing sockeye salmon. The results of this study would be the basis for developing a strategy for re-introducing the species into Okanogan Lake, the farthest upriver lake. Okanogan Lake (34,997 ha) is considerably larger than Osoyoos Lake (2,332 ha) and Lake Wenatchee (995 ha), and consequently has the potential for a substantial increase in rearing capacity.

Omak Creek Instream And Riparian Habitat Restoration

The CTCR and NRCS have ongoing efforts to restore instream and riparian habitat in Omak Creek. Restoration efforts include

- Point bar and log weir construction on the mainstem Omak Creek to divert flow from exposed banks.
- Riparian planting on Omak Creek and tributaries.
- Removal of two passage barriers in 1998.
- Redesign of the stream channel in lower Omak Creek to address severe erosion and lateral migration of the channel.
- In 2001, 2 more miles of the creek will be inventoried in order to develop further restoration plans.

Omak Creek projects are funded by the National Fish and Wildlife Federation, the Salmon Recovery Funding Board (Project #00-1683-D), and BPA (Project #200000100).

Upper Columbia River Salmonid Spawning Habitat Assessment

The CTCR is conducting an assessment of spawning habitat for anadromous salmonids from Chief Joseph Dam to Grand Coulee Dam. This project is funded by CTCR and conducted by Batelle, Inc.

Omak Creek Upland Restoration

The CTCR is restoring upland habitat. Efforts include:

- Road decommissioning – including pulling culverts and seeding roads.

- Changes in logging practices to minimize sediment delivery and to lessen the impact on hydrologic cycle.
- Fencing riparian areas in upland grazing allotments.
- Altering allotment sizes to better utilize existing vegetation.
- Incorporating grazing strategies such as rest-rotation and deferred grazing.

Salmon Creek Instream Habitat Restoration

For the past 90 years, the Okanogan Irrigation District (OID) has diverted 100 percent of the flow from Salmon Creek leaving 3.5 miles downstream of the diversion dam dry.

The CTCR, OID, and NRCS are involved in an effort to restore instream and riparian habitat in lower Salmon Creek. The primary goal is to restore fish passage for spring chinook and steelhead. Restoration efforts include:

- In May 1998, the CTCR and the OID formed a partnership to study the feasibility of providing water downstream of the diversion dam while maintaining the OID water delivery service.
- In 2000, acquired 1500 acre-feet of water from irrigators, to be spilled at the time of spring chinook smolt migration to allow downstream passage.
- In 2001, Phase 1 of the restoration of the lower 4.3 miles of Salmon Creek will begin. This will involve public outreach, field studies, NEPA, project design, and permitting.

Protection of existing spawning and rearing habitat along with alleviation of survival problems in summer rearing/overwintering in the lower tributaries are critical objectives of the strategy. Specific recommendations of habitat protection activities are being developed and pursued through the Mid-Columbia Habitat Conservation Plan currently under development. There is significant potential for increasing spawning and rearing habitat available to anadromous fish in this subbasin by addressing passage barriers such as Enloe Dam.

Supplementation is being implemented primarily through mid-Columbia PUD funding.

Scotch Creek Wildlife Area Upland Restoration

As a working cattle ranch, much of the uplands in this Wildlife Area were converted from native shrub-steppe grassland to grain fields of rye or wheat. Later these fields were seeded for livestock grazing. The native rangeland has been severely over-grazed, allowing the encroachment of diffuse knapweed and Russian knapweed. Deciduous trees (primarily water birch) were removed along the riparian corridor to accommodate alfalfa production. This practice drastically reduced critical wintering habitat for sharp-tailed grouse.

The Scotch Creek Wildlife Area management plan was approved by BPA in 1997. Since that time restoration and enhancement efforts have included planting shrubs, weed control, and grassland seedings.

Sinlahekin Wildlife Area Ecosystem Assessment And Restoration

The Sinlahekin Wildlife Area will conduct vegetation and small mammal inventories in 2001. They are in the preliminary stages of reintroducing fire the forest habitat. This involves thinning dense stands of ponderosa pine and Douglas-fir.

Loomis Forest Water Quality Monitoring

Loomis Water Quality Monitoring Project is in its fifth year. In 1995, the Washington Department of Natural Resources (WDNR) and the Washington Department of Ecology (WSDOE) cooperatively established several water quality monitoring sites on the Loomis State Forest. The purpose of these monitoring sites is to detect long-term changes in water quality (if any) as a result of management practices on the forest. A macroinvertebrate assessment and stream channel condition assessment is conducted annually at each of the study sites.

Loomis/Pasayten Forest Carnivores Tracking Survey

A forest carnivore study is being funded by WFDW and USFS in the mid-elevation forests of the eastern Pasayten Wilderness and the western Loomis Forest. The project is being managed by a University of Washington graduate student, and will run from Winter 2000-01 to Winter 2001-02.

Basin-Wide Water Quality Assessment

The Okanogan Conservation District (OCD) began a water quality monitoring program in May 2000. There are 38 monitoring sites in 11 subdrainages. All sites are tested for pH, DO, temperature, turbidity, conductivity, and total dissolved solids. Seven of the sites are also tested for ammonia-nitrogen, nitrate-nitrite, total per sulfate (TPN), dissolved phosphorous, total phosphorus, total alkalinity, total suspended solids, and fecal coliform. During storm events sites are tested for the presence of heavy metals. There is also a pesticide and organochloride scan, and a macroinvertebrate survey.

Bonneville Power Administration

The Bonneville Power Administration has several recent and ongoing efforts in the Okanogan Basin (Table 28).

Table 28: Recent and Existing BPA projects in the Okanogan Basin.

Location	State	Proj. #	Project Description	Agency	ProjTitle	Milestones	Short Project Description
Okanogan basin	BC	198347700	Tributary Passage	IEC BEAK Cnslts.	Enloe Dam passage	Project biologists inventoried the aquatic habitat of 4 major tributaries and 59 stream reaches in the mainstem of the Similkameen River in northeastern Washington above Enloe Dam. Streamflows were measured and water samples analyzed for contaminants.	Study of passage issues at Enloe Dam and potential salmonid habitat above the dam. Develop a preferred alternative.
Okanogan basin	WA	199604200	Planning	CCT	Okanogan Focus Watershed	Due to a water quality study currently underway by the Okanogan County Public Works and the Okanogan Conservation which would serve some functions similar to this project, it was decided to postpone the focus watershed effort for the whole basin and conce	Initiate the coordination of a watershed planning project that will assist with the restoration and enhancement of the anadromous fish resources of the Okanogan River basin. Gather data pertinent to current, and desired watershed conditions.
Okanogan basin	WA	199505600	Land Purchase / Enhanceme nt	WDFW	Scotch Ck Wildlife Area enhancem ent	Not recorded	Purchase and initiate enhancement activities on at the Scotch Creek Wildlife Area sites: Scotch Creek, Pogue Mtn, Chesaw and Tunk Valley Units in the Okanogan Basin.
Upper Columbia basin	WA	199506700	Land Purchase / Enhanceme nt	CCT	CCT Perfomanc e contract	Purchased 11,720 acres for $6,401,516 from the Berg Brothers. The tract lies between Whitmore Mtn and the Columbia River and is part of the Hellsgate Winter Range. Baseline HEP field work and analysis completed for about 4,800 acres.	Acquire minimum habitat units to be permanently protected for wildlife as outlined in a MOA with the Colville Tribe. The Berg Brothers Habitat Area between Whitmore Mtn and the Columbia River is one tract.
Upper Columbia Basin	WA	198503800	Facility Design / Construction	CCT	CCT hatchery	The Colville Confederated Tribes received the construction contract for the resident fish hatchery in July 1988. Construction was completed October 1, 1989.	Produce 22,679 kg (50,000 lbs.) of resident fish that include brook trout, rainbow trout and lahontan cutthroat trout. All the fish will be released into reservation waters, including boundary waters in an effort to provide a successful subsistence/recre
Upper Columbia Basin	WA	198503801	Education	CCT	CCT cultural training program	Six individuals were trained in the field of fish culture to operate the Colville Tribal Trout Hatchery. Two individuals were chosen to assist the hatchery manager in operation and maintenance of the facility. The training was completed in July 1989.	Training of 6 members of the Colville Tribe to operate the Colville Tribal Trout Hatchery.
Upper Columbia Basin	WA	199404100	Mitigation / Recovery	CCT	CCT wildlife mitigation coordinatio n	The CCT developed and implemented a public involvement program to review wildlife mitigation proposals. This included an Information Hot Line, brochures, maps, and committee and general meetings.	Develop and implement a public involvement program to reveiw wildlife mitigation proposals on the Colville Reservation. Coordinate such activities with BPA to facilitate NEPA requirements.
Okanogan Basin	BC	20001300		CCT			Evaluation of experimental re-introduction of sockeye salmon into Skaha Lake
Okanogan Basin	WA	200000100		CCT			Improvement of anadromous fish habitat and passage in Omak Creek

Habitat Conservation Plan for Wells, Rocky Reach and Rock Island Hydroelectric Projects

The CTCR is in the process of creating Habitat Conservation Plans (HCPs) for the three Columbia River hydroelectric projects.

Proposed Actions by Management Agencies

Okanogan River Sockeye Population

An experimental re-introduction of sockeye salmon in Skaha Lake has been proposed. The goal is to stabilize and rebuild the Okanogan River sockeye population. This study would assess the potential risks and benefits of reintroducing sockeye salmon. Potential risks include disease transfer, exotic species introduction, competition. Potential benefits include increased commercial, sport and tribal fisheries. The results of the study would be the basis for developing a strategy for reintroduction sockeye into Okanogan Lake, the farthest upriver lake. Okanogan Lake is considerably larger than Lake Osoyoos and Lake Wenatchee, and has the potential for a substantial increase in rearing capacity.

Other Proposed Actions

Appendix J includes the Okanogan National Forest Schedule of Proposed Actions (SOPA) for 2001. Appendix O lists projects proposed by the Confederated Tribes of the Colville Reservation.

Subbasin Habitat Reports (Limiting Factors Analysis)

Notice to Readers

This report chapter contains a final draft version of the Okanogan/Similkameen Limiting Factors Analysis (LFA)[1]. This report is sponsored by the Confederated Colville Tribes and being developed in conjunction with the Washington State Conservation Commission as provided for in Engrossed Substitute House Bill 2496 (1998). Some material is duplicated. However, the stand-alone report provides additional detail in key areas.

[1] *Fisher J. S. & K. S. Wolf, et al. 2001. Golder Associates/ENRIX: Report to the Confederated Colville Tribes Limiting Factors Analysis for the Okanogan Watershed.*

Introduction

Under the Salmon Recovery Act—RCW 75.46, passed as House Bill 2496, and later revised as Senate Bill 5595, the Washington Conservation Commission (WCC) is charged with administrating the identification of the habitat factors limiting the production of salmonids throughout the watersheds of the State of Washington. This information is intended as a tool to guide Lead Entity groups and the Salmon Recovery Funding Board (SRFB) in prioritizing salmonid habitat restoration and protection projects seeking state and federal funds. Specifically, ESHB 2496 in part:

- directs the WCC, in consultation with local government and the tribes, to invite private, federal, state, tribal and local government personnel with appropriate expertise to act as a technical advisory group (section 090, subsection 1, RCW 75.46);
- directs the assembled technical advisory group to identify limiting factors for salmonid production that relate specifically to habitat (section 090, subsection 3, RCW 75.46);
- defines limiting factors as "conditions that limit the ability of habitat to fully sustain populations of salmon." (section 010, subsection 5, RCW 75.46);
- defines salmon as "all members of the family Salmonidae that are capable of self-sustaining, natural production." (section 010, subsection 7, RCW 75.46).

The overall goal of the limiting factors assessments overseen throughout the state by the WCC is to identify habitat factors limiting production of anadromous salmonids in Washington's major watersheds. The responsibilities assigned to the WCC under ESHB 2496 do not constitute a full limiting factors analysis, as the exercise does not identify which factors limiting production are *most* limited—at either the watershed *or* sub-watershed scale. Furthermore, the process focuses on the habitat elements of a watershed only, and does not consider in depth how hatcheries, hydropower, water quantity and harvest management potentially affect salmonid production. Collateral watershed planning efforts detailed under ESHB 2514 heavily focus on water quantity evaluations, with some examination of habitat as well.

Beginning in October 2000, a technical advisory group (TAG) consisting of persons with technical/professional knowledge of the Okanogan watershed was convened. Through a series of meetings held between late 2000 and July 2001, input was solicited from TAG participants regarding existing data, published reports, and their professional knowledge of habitat conditions in the watershed. The information was then assembled into draft chapters of the report and circulated for review and comments. The TAG was then reconvened in August 2001 to critique the draft final document, consider limiting factor ratings on the sub-watershed level, and develop associated action item recommendations. This September 2001 final draft of the Okanogan LFA reflects the reviews of the draft distributed in August 2001to the TAG for comment.

Given the limited data on fish habitat conditions in the Okanogan watershed, professional knowledge was heavily relied upon in rating habitat at the sub-watershed and/or reach level. Sub-watershed habitat conditions were rated as "Good", "Fair" or "Poor" based on criteria outlined in chapter 4 of this document. A quantitative reach-by-reach assessment of habitat conditions in most of the Okanogan sub-watersheds was not funded and therefore could not be performed for this current effort. Such analyses are needed in some Okanogan sub-watersheds to refine the coordinated, watershed-level strategy that appropriately protects and restores salmonid habitat. Coordinated on-the-ground habitat assessment and rehabilitation efforts will ultimately facilitate the sustainability of anadromous salmonids in the naturally suitable habitats of the Okanogan watershed.

The Role of Habitat in the Natural Reproduction of Salmonids

Washington State anadromous salmonid populations have evolved in their specific habitats during the last 10,000 years (Miller 1965). While there continues to be debate over the specific numeric tolerance and preferences of habitat conditions required by salmonids, the following elements of habitat are generally accepted as necessary for the continued survival of all salmonid species:

- cool, clean, well-oxygenated water free of toxic pollutant concentrations;
- in-stream flows that resemble the natural hydrology of the watershed, maintaining adequate flows during low flow periods and minimizing the frequency and magnitude of peak flows (e.g., stormwater);
- clean spawning gravels with limited fine sediment embeddness, and lacking toxic materials;
- sufficient pool area and frequency to support juvenile rearing and dispersal, and resting/staging areas for returning adults;
- in-stream large woody debris or other suitable in-stream cover that is of sufficient size given a stream's channel morphology and flow to provide cover, create pools, and provide habitat diversity;
- unobstructed migration for juveniles and adults to and from their stream of origin;
- riparian stands of sufficient height and breadth to provide cover, shade, LWD recruitment, and organic enrichment, ; and
- estuarine conditions that support the production of prey organisms for juvenile outmigrants as well as for rearing and returning adults.

Water chemistry, flow, and the physical attributes unique to each stream have helped shape the characteristics of each salmonid population in Washington's waters, including those that persist in the Okanogan watershed. These unique physical attributes resulted in distinct salmonid stocks for each salmonid species throughout their range. Stocks are considered "population units" of a species that do not extensively interbreed because of run timing specificity, or because of a stream's unique chemical and physical characteristics in a stocks natal spawning grounds. Spawning ground fidelity thereby minimizes the potential for genetic drift during reproduction, thus preserving the distinctiveness of each stock.

Salmonid stock survival requires that habitat needs are met for egg incubation, juvenile rearing, migration of juveniles to saltwater, estuary rearing, ocean rearing, adult migration to spawning areas, and spawning. These needs vary slightly by species and even by stock. The most critical components of salmonid habitat include water quality, water quantity and hydrology, basin geology, fluvial geomorphology, vegetation and riparian conditions. Changes in stream flows can alter water quality by affecting temperatures, decreasing the amount of available dissolved oxygen, sediment accumulation, and concentrating toxic materials. For example, water quality can be reduced by heavy sediment loads, which in turn can result in increased channel instability and decreased spawner success. The riparian zone interacts with the stream environment, providing nutrients and a food web base, woody debris for habitat and flow control (channel complexity), filtering runoff prior to surface water entry (water quality), and providing shade to aid in water temperature control. In turn, the riparian zone is affected by flows; thus, unnaturally dewatered reaches will, over time, be expected to have altered riparian habitats relative to their potential.

When adults return to spawn, they not only need adequate flows and water quality, but also unimpeded passage to natal grounds. They need pools with overhanging vegetative cover and in-stream structures such as root wads to provide for resting and shelter from predators. Successful spawning and incubation further requires clean, unimbedded gravel areas of appropriate patch size and diameter for each species. After entering freshwater, salmon have a limited time to migrate and spawn, sometimes as little as 2-3 weeks. Thus, delays may result in pre-spawn mortalities from disease or predation, or spawning in suboptimal locations.

During incubation floods can have great impacts on salmon populations by scouring and/embedding the gravel nests (redds) where salmon have deposited their eggs. Human activities have been shown to increase the amplitude and frequency of such flood flows whereas in undisturbed systems, upland vegetation stores water and shades snowpack slowing the rate of water runoff into the stream. A healthy river also has sinuosity with large pieces of wood contributed by an intact, mature riparian zone. The uplands and riparian areas both act to slow the speed of water downstream. Natural systems have access to floodplains where wetlands store flood water and later discharge this storage back to the river during lower flows. Under natural conditions, erosion and sediment transport are balanced to provide a constant supply of new gravel for spawning and incubation without increasing overall channel instability.

When the young fry emerge from the gravels, some species of salmonids such as chum, pink and ‘ocean-type’ chinook migrate quickly downstream toward the estuary while other species such as ‘stream-type’ chinook, coho and steelhead trout search for suitable rearing habitat within side channels and sloughs, tributaries, spring-fed "seep" areas, stream margins, or lakes (sockeye); the freshwater residency of these species may last for two years before smoltification. Quiet water margins and off channel areas are vital for early juvenile habitat. The presence of woody debris and overhead cover aid in food and nutrient inputs as well as provide protection from predators. As growth continues, the juvenile salmonids (parr) will move away from the quiet shallow areas into deeper, faster water.

During the winter, salmonids require habitat that will sustain growth and protect them from predators and harsh winter conditions. Habitat use is determined by behavior changes associated with declining temperatures in the fall and winter. Behavior changes vary by species and life stage (Bjornn and Reiser 1991). In a study of seasonal habitat use of juvenile chinook salmon and steelhead in the Wenatchee River (Don Chapman Consultants 1989) juveniles were located along the stream margin in boulder zones from October to March. During the day they hid in interstitial spaces among boulders; at night both species stationed on boulders and sand adjacent to their daytime habitat. When water temperatures dropped below 50° F (10° C), juveniles were not observed in the water column during the daytime, but remained in the substrate. Adult steelhead that overwinter in the upper-Columbia region are thought to generally seek refuge in the mainstem Columbia River. Some adults will also seek refuge in deep pools of the mainstem tributaries to the Columbia River (C. Peven, personal communication) but may return to the Columbia River if instream water temperatures become too harsh (L. Brown, personal communication).

The following spring, smolts begin their seaward migration. Flows, food and cover that provides protection from predators are critical. Once again the unique natural flow regime in each river that shaped the population's characteristics through adaptation over the last 10,000 years, plays an important role in the salmonids behavior and survival. In contrast to natural flow regimes, salmonids from the upper-Columbia region must migrate through a river system that has been highly altered by hydroelectric development. Hydropower dams converted the free-flowing Columbia River to a series of reservoirs upstream from the Bonneville Dam. Subyearling summer chinook salmon produced in upper-Columbia tributaries tend now to spend several weeks in the reservoirs before they arrive at Priest Rapids Dam beginning in August (Chapman et al. 1994a). Delaying migration time can potentially increase mortality of juveniles salmonids or convert their life pattern from migratory to residual. Such residualism has been widely documented in Yakima river steelhead (Pearsons et al. 1996).

Once reaching the estuary, adequate natural habitat must exist to support the detritus-based food web upon which salmonids depend during the early portions of their marine life history. Habitat elements of greatest importance to juvenile salmonids in the marine environment include eelgrass beds, mudflats, and salt marshes. The processes that contribute nutrients and woody debris to these environments must be maintained to provide cover from predators and to sustain the food web. Common disruptions to these habitats include dikes, bulkheads, dredging and filling activities, pollution, and alteration of downstream components such as woody debris and sediment loads.

The distribution, seasonal abundance and migratory behavior of salmon and steelhead exiting the estuary for the nearshore and offshore ocean environment varies considerably (Groot and Margolis 1991; Chapman et al. 1994b). The movements of chinook at sea are more complicated than those of sockeye and pink salmon. Ocean residence for spring chinook last from 2-4 years compared to 3-4 years for summer/fall chinook. First-year chinook remain along the continental shelf north to the Gulf of Alaska more than other first-year salmon species (Chapman et al. 1995). In contrast, distribution of young steelhead differ in time and space from any salmon. Steelhead do not remain along the coastal belt but move directly seaward during their first ocean summer (Chapman et al. 1994b).

In addition to the relationships between various salmonid species and their habitats, there are also interactions between the species that have evolved over the last 10,000 years. These interactions represent a delicate balance affected by habitat quality and habitat quantity. In the Okanogan watershed, this relationship is complicated by the introduction of non-native salmonid and centrarchid species (e.g., brook trout, smallmouth bass), the introduction of salmonid hatchery stocks, and the extirpation of native coho and bull trout stocks. Salmonids exhibit a variety of life history patterns often as a result of their adaptability to a complex and fluctuating environment (Lestelle et al. 1996). Maintaining access to sufficient quantities of high quality habitat contributes to supporting multiple life history stages for all salmonid species, thereby increasing a population’s resiliency to environmental change, whether that change was natural or human-caused.

Okanogan Watershed Characteristics and Conditions

Watershed Overview

The Okanogan River originates in British Columbia and flows through a series of four large lake systems or impoundments before reaching the United States (**Figure 2-1**). These lakes, from the headwaters progressing downstream include: Okanogan Lake, Skaha Lake, Lake Vaseaux and Lake Osoyoos. The river eventually flows into the Columbia River at Columbia River mile 533.5. The mainstem Okanogan River within Washington State, stretches some 79 miles from its confluence with the Columbia River to outlet of Lake Osoyoos (WDNR 1982). The watershed encompasses about 2,600 square miles within the state of Washington, and about 6,300 square miles within the Canadian province of British Columbia (WDOE 1995). Using a modified 5th field hydrologic unit scale (i.e., HUC 5), the watershed was delineated into 19 sub-watersheds for this LFA (Figure 2-2). Sub-watershed characteristics are described in Chapter 5.

The eastern and western boundaries of the mainstem Okanogan basin are steep, jagged ridgelines at elevations ranging from 1,500 feet to more than 6,000 feet above the basin floor (WDOE 1995). The average width of the drainage area for the mainstem is approximately 35 miles, and the floodplain of the Okanogan River valley averages about a mile in width. The mainstem's elevation descends from an elevation of about 920 feet at the international boundary to about 780 feet at the river's confluence with the Columbia River. Osoyoos Lake occupies the northernmost four miles of the Okanogan valley floor in Washington and extends several miles into Canada. Multiple natural terraces formed mostly of glacially deposited gravel rise locally as much as 500 feet above the valley floor to the foot of, and between, the lateral ridges.

Land Ownership and Use

The Okanogan/Similkameen watershed is the largest and most complex of the four mid-Columbia River tributaries: Entiat, Okanogan, Methow and Wenatchee. A large portion of the watershed within the U.S. is privately owned (**Figure 2-2**). The Colville Indian Reservation, located in the southeast part of the watershed, comprises about 25 percent of the watershed (OWC 2000). Public ownership comprises 41 percent of the watershed, including 21 percent owned by the USFS, 17 percent owned by the State of Washington, 3 percent owned by the Bureau of Land Management, and the rest owned by miscellaneous agencies (**Table 2-1**). The remaining 34 percent of the watershed is under private ownership (OWC 2000).

Land use in the Okanogan River watershed includes agriculture, range, timber, residential and recreation, and some industrial and commercial (**Table 2-2, Figure 2-3**). Forest and rangelands about equally dominate land use. The watershed contains approximately 36,000 to 40,000 acres of irrigated area. About 60 percent of that acreage (24,421 acres) is contained within irrigation districts or ditch companies (WDOE 1995): Okanogan Irrigation District represents about 20% of the irrigation district lands in the Okanogan River Basin. Timber production for the Okanogan National Forest increased from World War II until the mid-1960s (USFS 1997). Timber production since the 60's has declined somewhat.

Table 2-1. Okanogan Watershed Land Ownership

Land Owners	**Approximate Acres**
Department of Agriculture - Forest Service	357,000
Department of the Interior	
Bureau of Land Management	48,000
Fish and Wildlife Service	2,750
Department of Defense	375
Federal Subtotal	*408,125*
Washington State	
Department of Natural Resources	245,000
Department of Fish & Wildlife	29,873
Department of Parks & Recreation	600
State Subtotal	*275,473*
County	300
Municipal	2,900
Total Public (federal, state, & local)	**686,798**
Tribal	422,000
Total Private	**559,000**
Total Land Area	***1,667,798***

Source: USDA Natural Resources Conservation Service GIS data, unpublished

Table 2-2. Okanogan Watershed Land Cover and Use

Land Use	Approximate Acres
Forest	787,070
Range	754,996
Cropland	101,930
Urban	5,737
Other	18,065
Total Land Area	***1,667,798***

Source: USDA Natural Resources Conservation Service GIS data, unpublished

Irrigation Districts

There are nine irrigation districts, reclamation districts and canal companies operating in the Okanogan Watershed (**Table 2-3**). These water providers comprise the bulk of irrigation water delivery from surface water sources to approximately 24,710 acres (OCD, 1989). **Table 2-4** displays information about surface and ground water rights in the basin. .

Table 2-3. Irrigation Districts of the Okanogan Watershed

Irrigation District	Source	Irrigated Acres	Length	Flow
Okanogan Irrigation District	Salmon Ck, Okanogan R.	5,032	50 mi. piped. 7.6 mi. lined canal	15,000 acre ft/yr
Oroville Tonasket Irrigation Project	Similkameen R., Lk Osoyoos, Okanogan R.	10,300	110 mi. pipe 10 mi. canal	41,200 ac ft/yr
Whitestone Irrigation and Power Company	Toats Coulee	3,000	16 mi. pipe 14 mi lined canal	45 cfs max
Pleasant Valley Irrigation Project	Loup Loup Creek, Okanogan River	2,000	3 mi. pipe 3 mi. canal	17 cfs max
Helensdale Irrigation District	Loup Loup Ck., Okanogan River	225	2 mi. pipe	
Brewster Flat Irrigation Project	Columbia River @ Chief Joseph Dam	2,832	28 mi. pipe	60 cfs max
Aeneas Lk. Irrigation District	Aeneas Lake	1400	4 mi. pipe	12 cfs
Alta Vista		40	1 mi. pipe	1 cfs
Black Bear	Sinlahekin Ck	105	2.5 mi. pipe	2 cfs

Table 2-4. Summary of Water Rights in the Okanogan Watershed (WDOE 1995)

Water Source	Number of permits	Quantity (acre feet)	Area (acres)	Percent used for Irrigation
Surface	470	105,414	67,443	98%
Ground	307	39,344	10,437	56%

Geology and Topography

The Okanogan River basin geology and geomorphology is influenced by the Cascade Range, Northern Rockies and Columbia Plateau Systems which border it on the west and south sides, respectively. During the Quaternary Period, glaciers sculpted the landscape below 5,000 feet, covering large areas with glacial drift and fluviolacustrine sediments. Small alpine glaciers were also active at higher elevations. Cascade volcanoes were active during the Pleistocene and into the Holocene. Deposits of volcanic ash from these eruptions occur within the area (Hansen

1998). Due to glacial activity, rock outcrops were exposed in many places and formed a complex pattern with the materials deposited by glaciation. Much of the bedrock has been weathered to shallow soils (SCS 1980).

The erosive action at the base of the glacial ice create unconsolidated and unsorted mixtures of silt, sand, gravel, and stones. Glacial fluvial meltwater streams carried large quantities of sand and gravel, creating thick deposits of sorted materials. In areas of low gradient or local impoundment, glacial meltwater created lacustrine deposits of clay soils. Some deposits of glacial drift are mantled by volcanic ash (SCS 1980).

Soils and Vegetation

Most Okanogan County soils are formed in materials derived mainly from volcanic ash and glaciation from the last 10,000 years (**Figure 2-4**). Those soils most influenced by ash are in the northern part, at elevations above 3,000 feet (SCS 1980). Because the Okanogan Valley is narrow with steep slopes, there is a high amount of runoff into the river. High rates of drainage are also attributed to streambank instability, which introduces a large amount of sedimentation. The most erosive soils along the Okanogan River are the Colville silt loams, and the Bosel fine sandy loams. Some factors that accelerate erosion are over grazing, mining sites, logging activities, roadwork and irrigation. The lack of woody vegetation on the streambanks along the Okanogan may be increasing erosion rates. Soils are slightly acid to alkaline, and originate from sandy loam to silt loam soils formed in volcanic ash, glacial materials, and weathered granite, schist, limestone, shale and gneiss.

A semiarid climate, with dry warm summers and moderately cold winters supports such native species as big sagebrush, rabbitbrush, and bitterbrush in the valleys and on terraces (SCS 1980). The climate is influenced by the barrier to marine air that the Cascade Mountain Range provides, as well as by the mountain and valley formations of the region. Precipitation in the watershed ranges from more than 40 inches in the western mountain region to approximately 8 inches at the confluence of the Okanogan and Columbia Rivers.

Where annual precipitation is 8 to 11 inches, grassland is the dominant type of vegetation. In areas where the annual precipitation is 11 to 14 inches (such as in the middle and lower reaches of the Salmon watershed), the importance of Idaho fescue and bluebunch wheatgrass in the plant community increases. Perennial grasses include bluebunch wheatgrass, and giant wildrye. Non-native plant species include wheatgrass, Russian thistle, common mullein and wooley plantain. Forested lands comprise approximately 47% of the Okanogan watershed and receive approximately 75% of the total annual precipitation (Gullidge 1977) The density of the forest vegetation increases at elevations above 3,000 feet, where the annual precipitation is greater than 14 inches. Yellow pine (*Pinus ponderosa*) dominates in areas where the annual precipitation is 14 to 16 inches (e.g., the upper Salmon watershed). Douglas-fir (*Pseudotsuga douglasi*) is dominant in areas where the annual precipitation is 16 to 18 inches (SCS 1980).

Mean annual temperature for the Okanogan Watershed is 49^0F. The average temperature for January is 21^0F. and the July average is 73^0F. Wind velocities throughout the region are calm to moderate and generally originate from the north or south. Thunderstorms occur occasionally in the watershed during late spring and early summer. Summer months see approximately five cloudy days per month compared to winter months, which average approximately 20 cloudy days per month. On average, there are 150 frost-free days each year in the main Okanogan River

Valley. The number of frost-free days reaches only about 75 days in the surrounding hills and uplands (NOAA, 1994).

Water Quantity/Hydrology

Snowfall represents about 50-75% of the annual precipitation during the winter months. Rainfall and snowmelt runoff contribute approximately 3% to the average annual gauged streamflow of the Okanogan River at Mallot (USGS Gauge No. 12447200) with the remainder provided from Canadian contributions upstream (**Figure 2-5**). Average annual runoff for the Okanogan River as measured at Mallot is 2,220,000 acre-ft. With about 2,150,000 acre-ft contributed annually from the Canadian province of British Columbia and from the Similkameen tributary (OWC 2000). Annual runoff at Mallot has ranged between a minimum of 860,000 acre-ft and maximum of 4,000,000 acre-ft. Average annual flows on the Okanogan and Similkameen Rivers have not changed significantly since gauging began in 1911 (WDOE 1995). However, seasonal low streamflows are very much affected by water usage for irrigation, water supply, and other activities.

Peak annual flows occur usually occur during a two or three week period in late May and early June, but the timing of the peak can vary substantially based on snow pack. On average, these hydrographic peaks account for approximately one-half of the annual runoff volume into the watershed. Minimum annual flows occur in early fall to mid-winter (September through March). In arid climates such as the Okanogan valley, almost all precipitation occurring during the warm months either evaporates or is absorbed by the soil layer. Usually only a very small amount of precipitation directly contributes to streamflow from late June through October. However, isolated summer thunderstorms in discrete sub-watersheds can yield flash flooding, resulting in devastating consequences to riparian habitats and aquatic biota. Such flooding events are non-uniform in their distribution among tributary drainages, with occurrence intervals approximately every 2 years in the Okanogan watershed overall. These events play a highly significant role in shaping aquatic habitats in the Okanogan watershed, especially within its tributaries.

Watershed hydrology within the Okanogan watershed is affected by the road network and other impervious surfaces. According to GIS interpretations, there are 153 miles of Washington State highways, 1,774 miles of county roads, and 70 miles of railroad in Okanogan county. Relative to more urbanized counties, these estimates are low in proportion to the total watershed area encompassed by the Okanogan watershed. Notwithstanding, significant impacts to watershed hydrology are realized when total impervious surface area in a watershed approaches 10% (Booth and Jackson 1997).

Water Quality

Ecology’s 1997 Section 303(d) list (Impaired and Threatened Waterbodies Requiring Additional Pollution Controls) includes the Okanogan River for “failure to meet water quality standards for temperature, dissolved oxygen, pH, and fecal coliform” (WDOE 1998). There is a “consistent late summer water temperature criteria violation (annual violations from 1983-1993) (**Table 2-5**). Fish within the watershed are subject to poor water quality and low flow conditions, as well as critically high water temperatures during summer months” (WDOE 1998). Temperature and flow listings pose the most significant problems to salmon recovery in the Okanogan watershed. WDOE is currently in the technical assessment phase of developing Total Maximum Daily Loads (TMDLs) for PCBs and DDT in the Okanogan watershed.

Table 2-5. Okanogan Watershed TMDL listings

Water Body	Parameter
Okanogan River	Temperature, DO, pH, fecal coliform, PCB-1260, PCB-1254, 4,4'-DDE*, 4,4'-DDD
Similkameen River	Temperature, arsenic
Salmon Creek	Instream flow
NinemileCreek	DDT
Elgin Cr. ("unnamed")	DDT
Tallant Creek	DDT
Lake Osoyoos	4,4'-DDE*, 4,4'-DDD*

*break-down products of DDT

Nitrogen

Detectable nitrogen in surface waters most often is measured in the form of nitrate, the final oxidized form of ammonia. By itself, nitrate is essentially non-toxic to aquatic life, but is indicative of nutrient enrichment that can lead to eutrophication and ultimately shift the distribution and abundance of aquatic life towards species more tolerant of nutrient rich systems. The nitrate values recorded on the Okanogan and Similkameen Rivers are well below any action level for health standards and thus acceptable for all Class A water uses. Common sources for nitrogen include on-site sewage disposal systems, discharges from municipal sewer treatment plants, irrigation system return flows, fertilizer applications for both agricultural and residential uses, waterfowl congregating on the waterbody, and atmospheric deposition.

Dissolved Oxygen

Dissolved oxygen concentrations below approximately 5 mg/L are considered stressful to salmonids and generally are not observed in fluvial environments where aeration should ensure adequate saturation (Fisher 2000). Saturation levels at altitudes and maximum temperatures seen in the Okanogan watershed (e.g., 1,000 ft and 75 degrees Farenheit) would approximate 8.4 mg/L. Dissolved oxygen (DO) concentrations in the Okanogan River system are generally at or above saturation levels at all sites, even during the summer months when the water temperatures are elevated. Dissolved oxygen concentrations in Malott have had the lowest saturation values detected. This is predictable, since the monitoring station is located downstream of the major municipalities in the basin, where sewage and stormwater releases increase the biological oxygen demand (BOD). In addition, there is very little turbulent water between the Okanogan monitoring station and the Malott station to facilitate reaeration. Backwaters from the Wells Pool will also limit the potential aeration of Okanogan mainstem waters in this reach.

Temperature

Okanogan River water temperatures have regularly exceeded lethal tolerance levels for salmonids in the mid-to-late summer. These exceedences are partly a result of natural conditions of low gradient and solar radiation on the natural upstream lakes, but are exacerbated by dam impoundments along the mainstem, sedimentation, and irrigation withdrawals that reduce baseflows. Temperatures of the mainstem are significantly elevated prior to entering Washington State. High water temperatures in late summer and fall often form a thermal barrier, effectively excluding juvenile salmon from rearing in most of the basin, except during the first few weeks after emergence (Chapman et al. 1994a). At times, high water temperatures in the lower Okanogan River have also blocked adult anadromous salmonid passage. For example, adult sockeye that are sometimes thermally blocked through the lower Okanogan River downstream of

Lake Osoyoos during late July and early August (Pratt et al. 1991). Thus, such water quality limitations represent passage barriers when they exist.

Water temperatures pose the most difficult problem for increasing survival of most ocean-type and stream-type salmonids in the watershed. Chapman et al. (1994a) plotted water temperature in the Okanogan River at Oroville and Tonasket, showing that mean mid-summer daily temperatures were frequently well over 70° F in 1986 and 1987. Hansen (1993) also confirmed temperatures in that range or higher near Zosel Dam and Lake Osoyoos during 1992. Hansen (1993) speculated that the alteration of flow regimes by the upstream dam in Lake Osoyoos have exacerbated the problem of thermal barriers.

pH

pH defines the measure of acidity in a solution. The pH values measured in Okanogan waters are routinely measured in the slightly to moderately alkaline range of 7.5 to 9 (C. Nelson, TAG), primarily as a result of the highly calcareous soils found over much of the region that exceed even those of the "limebelt region" (C. Nelson, TAG). Recorded pH values have risen approximately 0.3 points over the last 20-30 years, and, in some cases, are at the upper limits of the desired range for salmonid health. This alkaline condition may exert a stabilizing effect on the potential toxicity of some of the heavy metals released into the watershed by limiting their particles and sediments, and out of solution (WATERSHEDS 1997). Influences on the pH level include acid mine drainage, atmospheric deposition (acid rain), calcium, calcium carbonate, effluent water and land use practices. The effects of surface water withdrawals on pH values has not been fully evaluated, but could potentially result in a gradual elevation by concentrating alkaline solutes from groundwater contributions into surface waters.

Fecal coliform

Evidence of fecal coliform in surface waters are primarily indicative of sewage or livestock contamination, and can be used as a surrogate for nutrient enrichment. Direct effects of fecal coliform on salmonid health and abundance have not been established, so this metric only an indirect measure of water quality suitability for salmonids in the Okanogan watershed. Data collected from 1977 to 1997 indicate that fecal coliform is not a concern at most existing water quality monitoring sites. Currently, high counts of fecal coliform have been recorded from Bonaparte Creek for which a livestock source is suspected. The Malott station had 9 exceedances of water quality criteria in 163 recorded samples; the Okanogan station had 5 exceedences in 128 observations; and the Oroville stations had 0 exceedences out of 190 observations on the Okanogan, and 1 exceedence out of 208 observations on the Similkameen (WDOE 1997c). These results are all well below state water quality standards, which allow for up to 10% of the samples to exceed the published standard as long as the mean value of the samples is below 100 colonies per 100 ml.

Sedimentation

Sediment recruitment into the Okanogan mainstem and tributary systems is contributed from roads, logging, agricultural practices, and hydrological manipulations. When sediment recruitment into a stream channel exceeds the downstream sediment transport rate streambeds fill and spread, creating shallow water habitats more susceptible to thermal radiation and chronicly elevated temperatures. Unnaturally warmer waters, low velocities and heavy sedimentation in the mainstem favor non-anadromous species, which can outcompete native stocks. Sediments deposited on spawning gravels can entomb salmon redds and cause the direct mortality of eggs and larvae residing therein. Sediment deposition in riffle zones, normally cleared of fine sediments by natural sediment transport processes, can reduce macroinvertebrate habitat quality, resulting in a shift towards species tolerant of disturbed habitats (e.g., Chironomidae) in lieu of species that require cleaner waters (e.g., Ephemeroptera, Tricoptera). Such shifts in macroinvertebrate abundance and diversity can indirectly affect salmonids by compromising food supplies needed by rearing salmonids.

Roads are likely the greatest contributing source of sediment to streams in the Okanogan watershed. Sedimentation is highest at road crossings over stream channels, along roads in close proximity to streams, along cut and fill slopes, and at roads and ditches that drain to stream channels. Private roads that access multiple parcels often do not have a coordinated maintenance program, leading to increased erosion and sedimentation. Roads affect streams by accelerating erosion and sediment delivery, altering channel morphology, and changing the runoff characteristics of watersheds (Furniss et al. 1991). Sediment delivery from roads also depends on factors such as distance from the slope, vegetation cover, and precipitation. In addition, noxious weeds tend to spread along roads because of the routinely disturbed habitat conditions found there that favor invasive species. Herbicide treatment of noxious weeds along roadsides can lead to contamination of nearby streams through accidental spills, direct runoff, or infiltration (USDA, USDI 2000).

Sediment delivery into streams is considered to be greater than natural erosion rates when road densities exceed 4 miles/sq.mile (Cederholm et al. 1981). Road density in most Okanogan sub-watersheds in the basin exceeds 4 miles/sq. mile. For example, there are an estimated 6.38 miles of road/sq mile in the Omak Creek sub-watershed, a system with significant sedimentation issues. Other systems are less impacted by the road network (e.g., Salmon Creek 2.2 miles/sq. mile (USDA, unpublished data) Omak Creek 6.38 miles/sq.mile (NRCS 1995).

Streams are particularly vulnerable to road-derived sediments when roads are located within the riparian zone buffers of streams. Tables 2-6 and 2-7 provide estimates of road miles near or within the riparian corridors of the Okanogan mainstem and select tributaries.

Table 2-6. Road Miles within 200 Feet of Streams in the Okanogan Basin

Sub-watershed	Non-Forest Service	Closed Forest Service	Open Forest Service	Total
Bonaparte Creek	41.4	1.7	5.1	48.2
Mainstem Okanogan	56.0	4.7	1.5	62.2
NE Okanogan	52.4	2.4	10.7	65.5
SE Okanogan	25.4	0.9	0.7	27.0
SW Okanogan	31.1	0.1	0.7	31.9
Salmon Creek	19.6	6.6	19.9	46.1
Similkameen River	43.1	0.2	7.2	50.5

Source: Unpublished data from USFS

Table 2-7. Road Miles within 50 feet of Streams in the Okanogan Basin (USDA, USDI 2000)

Sub-watershed	Miles of road within 50 feet of stream	Road crossings over streams
Bonaparte Creek	2.9	47
NE Okanogan River	4.3	46
Okanogan mainstem	4.5	87
Salmon Creek	6.4	109
Similkameen River	0.5	16

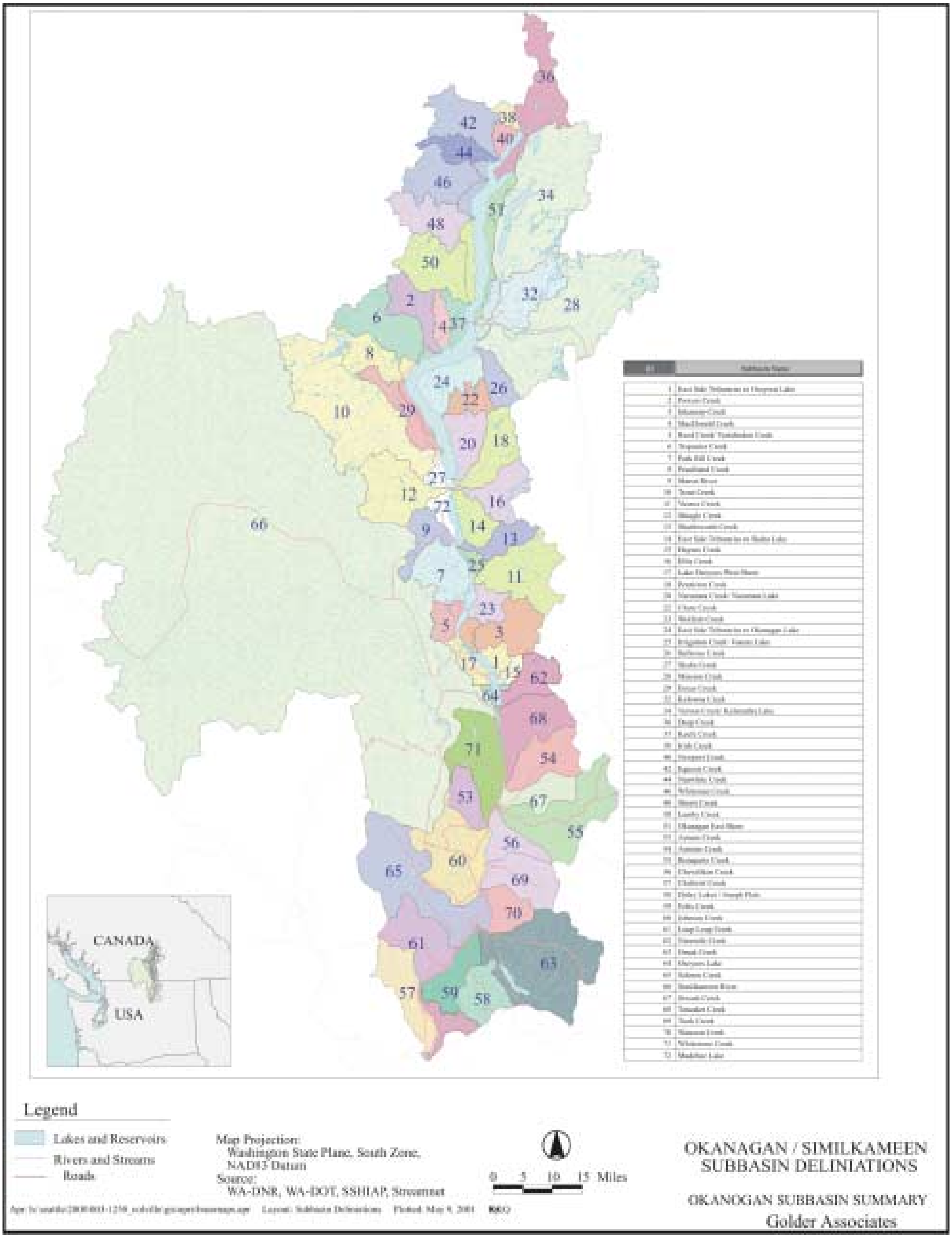


Figure 2-1. The Okanogan River Basin. Showing the Canadian and US portion of the watershed. Source: Okanogan Water Quality Management Plan, OWC 2000)

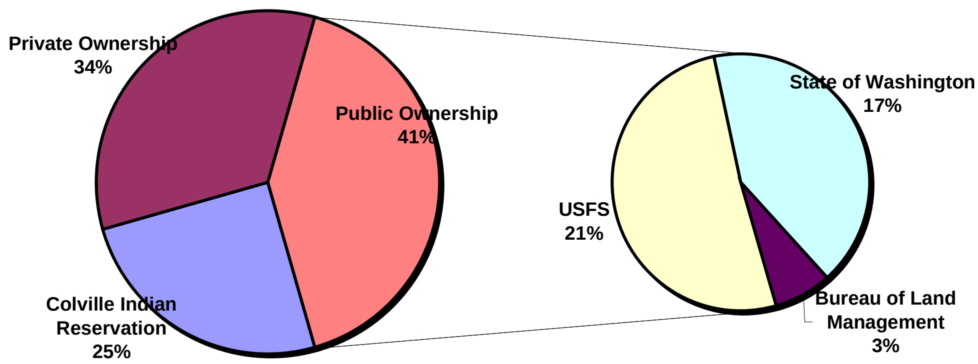
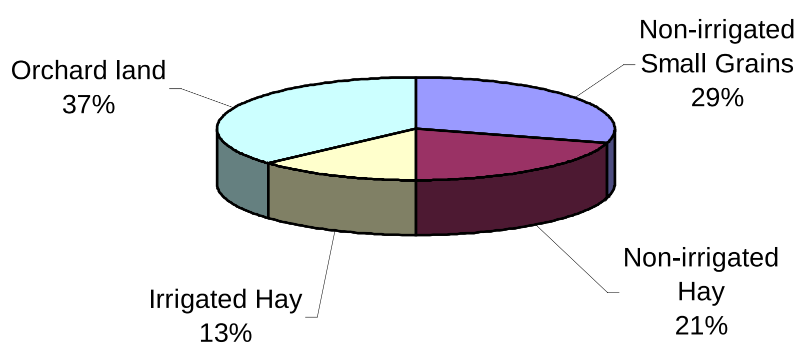


Figure 2-2. Land Ownership in the US portion of the Okanogan River Basin. Public ownership for federal and state are not listed if the percent acreage is less that 1%.

Figure 2-3: Major Crops of the Okanogan Basin (OWC 2000).



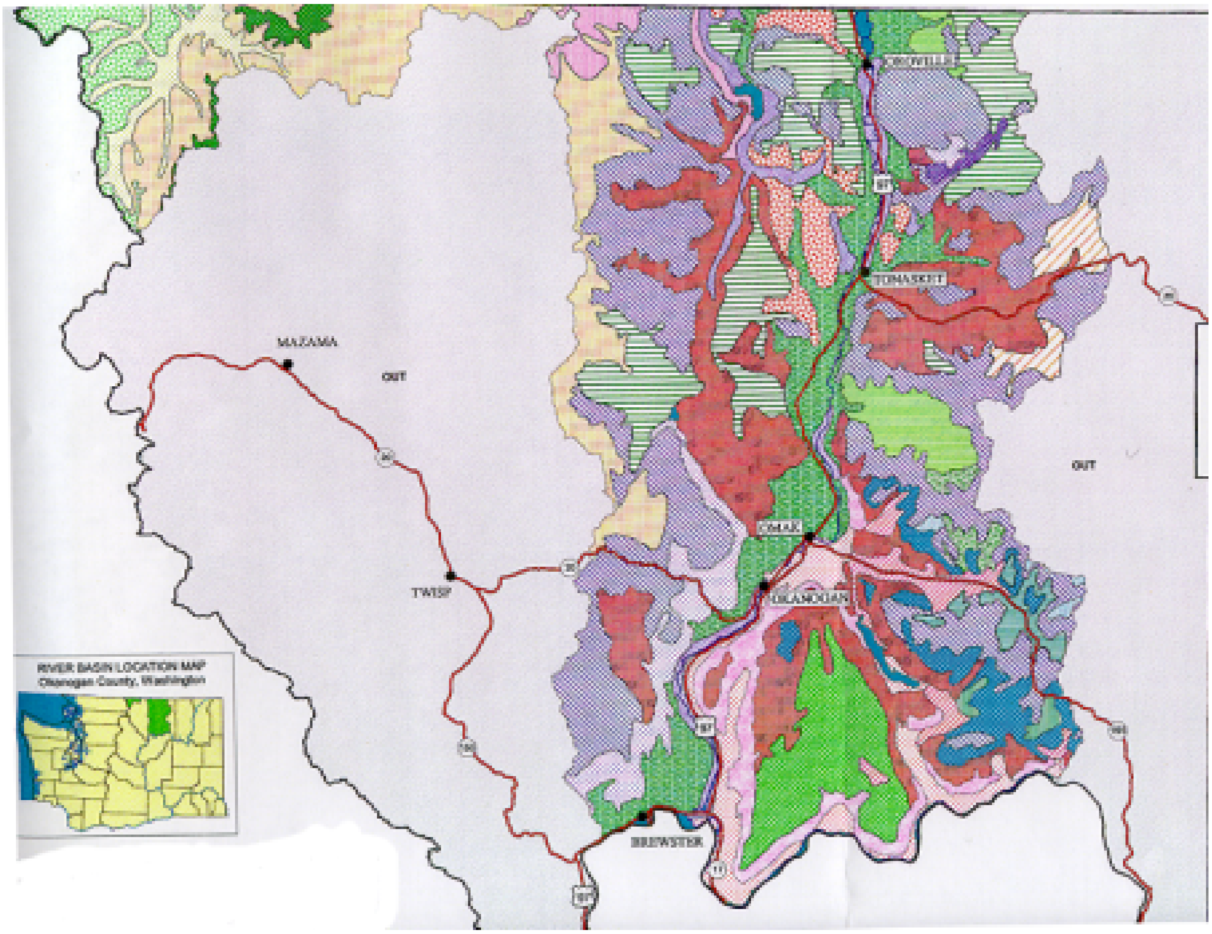


Figure 2-4. The soils found in the Okanogan River Basin. The soils are listed according to the USDA codes.
Source: Okanogan Water Quality Management Plan, OWC 2000)

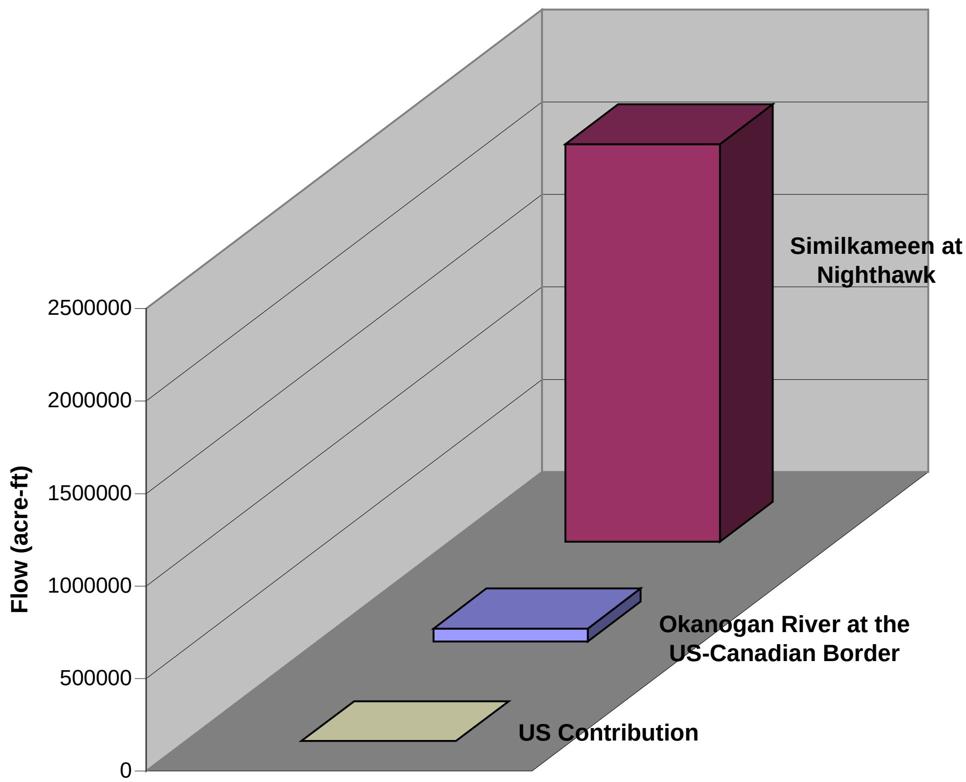


Figure 2-5. The USGS recording stations of annual flow for the Okanogan River. The contribution from each are calculated as the following:

Canada:	**Flow measured near the US / Canada border at Oroville, Washington Gage Station + flow measured on the Similkameen at Nighthawk, Washington.**
US:	**Flow measured at Malott, Washington – Candadian calculated contribution.**

Fish Distribution and Status

Fisheries Resources of the Okanogan River Watershed

The Okanogan River represents the uppermost tributary of the Columbia River currently accessible to anadromous salmonids. The upper Columbia supports anadromous stocks of chinook and sockeye salmon, and steelhead trout (**Figure A-1, A-2, A-3**). Chinook salmon stocks of the Columbia River basin are differentiated as ocean-type or stream-type fish, based on juvenile life history out-migration strategies. Ocean-type chinook juveniles migrate to sea as subyearlings, spend most of their ocean life in coastal waters and return to freshwater as adults a few months prior to spawning. Stream-type chinook migrate to sea as yearlings, exhibit extensive offshore migrations, and return to freshwater many months before spawning (Healey 1991). Within the Columbia River Basin, stream-type chinook tend to occur in upper tributaries and ocean-type chinook are produced in mainstem areas and lower tributaries (Waknitz et al. 1995). Stocks are further classified by their adult migrational patterns as spring-run, summer-run, and fall-run. Sockeye salmon exhibit a summer-run migrational pattern only. Steelhead in the Columbia river are divided into winter-run and summer-run stocks, based primarily on their state of sexual maturity at the time they enter freshwater and the duration of their spawning migration. The Okanogan watershed of the Columbia system specifically supports anadromous fish runs of summer run chinook salmon, sockeye salmon (*O. nerka*), and a remnant run of summer steelhead. In addition, a variety of resident species occupy habitats upstream of anadromous barriers in the system.

Stock status information on Okanogan fisheries resources is detailed in **Table 3-1**, and further described below. Sub-watershed information on species' use and distribution is provided in the sub-watershed summaries in chapter 4.

Table 3-1. SASSI Stock Status and Escapement numbers for chinook, sockeye and steelhead (WDFW and WWTIT 1994).

Species and Subbasin	SASSI Stock Status	Stock Origin	ESA Status	Maximum Upriver Okanogan Distribution	Mean Escapement
Okanogan					
Spring Chinook	Depressed	Native	Endangered, 1999	Considered Extirpated	NA
Summer Chinook	Depressed		Not listed	RM 26-77	363-2,300 (1977-1991)
Sockeye	Healthy	Native	Not listed	RM 90-106	65,000-64,700 (1977-1991)
Steelhead	Depressed	Mixed	Endangered, 1997	Not definitively established	114-837 (1982-1991)

Source: Washington State Salmon and Steelhead Stock Inventory, 1992.

Chinook Salmon Stock Status and Distribution in the Okanogan Watershed

Chinook salmon currently using the Okanogan generally are considered a summer run stock. However, Utter (1993) was unable to ascertain a genetic distinction between summer and fall chinook populations above Wells Dam (includes all Methow and Okanogan chinook), and past spawning ground surveys have referenced the Okanogan chinook stock as a summer/fall run (Miller and Hillman 1996, 1997, 1998). Spring chinook are considered extirpated from the Okanogan River drainage, although historical records indicate that they occurred in at least three systems: (1) Salmon Creek, prior to construction of the irrigation diversion dam (Craig and Suomela 1941), (2) tributaries upstream of Lake Osoyoos (Chapman et al. 1995), and (3) possibly Omak Creek (Fulton 1968). The Similkameen River, the largest tributary to the Okanogan, also likely supported spring chinook, but there is no conclusive evidence to support this theory. There were probably several life history strategies that historically existed in the Similkameen Watershed, prior to construction of Enloe Dam in 1920, although there is no clear evidence that chinook salmon passed the natural falls on the lower Similkameen River. Fall-run chinook are not known to have ever utilized the Okanogan watershed, perhaps due to the long migration involved.

According to the most recent salmon and steelhead stock status inventory (SASSI) (WDFW & WWTIT 1994), the summer chinook in the Okanogan are considered “depressed” (**Table 3-1**), although they have not been formally listed under the Endangered Species Act by the National Marine Fisheries Service. Both hatchery origin and wild (naturally-derived) chinook spawn in the Okanogan and Similkameen drainages, but native stocks (i.e., completely lacking hatchery-strain genetics) are not known to persist in the system. No sub-watershed characterization of summer-run Chinook stocks in the Okanogan watershed was considered in the original SASSI report, and long term monitoring of population trends is inadequate in most Okanogan tributaries to draw strong conclusions regarding the trends of sub-watershed Chinook stocks in the watershed.

The overall run strength of summer chinook salmon declined slightly in the mainstem Okanogan River, and increased slightly in the Similkameen River (its largest tributary) in the 1970s and 1980s (Chapman et al. 1994a). Summer chinook run sizes in the Okanogan averaged 532 fish in 1977 and 617 in 1985 (WDOE 1995). In 1998, the Colville Indian Nation harvested 759 chinook from a total population of 4,560 fish available to spawn in the Methow and Okanogan (inc. Similkameen) rivers (Murdoch and Miller 1999). Miller and Hilman (1998) estimated that between 14-72% of the chinook that pass Wells dam spawned in the Methow and Okanogan systems between 1980 and 1997. In 1998 Murdoch and Miller (1999) observed 88 and 276 redds in the Okanogan and Similkameen Rivers, respectively, representing an estimated escapement to these spawning grounds of 317 and 994 chinook, respectively (escapement figures assume 3.6 fish/redd). Thus, the most recent escapement estimates to the Okanogan system identified for this LFA indicates approximately 1,300 chinook are spawning in the system. Carcass retrievals, a subsample of the total spawning population, revealed that 33 and 52% of the spawners in the Okanogan mainstem and Similkameen, respectively, are of hatchery origin.

Adults enter the Okanogan River from July through late September, and spawn from late September through early November, peaking in mid-October (Peven and Duree 1997, Murdoch and Miller 1999). Current chinook spawning occurs in spatially discontinuous areas from the town of Malott upstream to Zosel Dam, approximately RM 64 of the Okanogan River (Murdoch and Miller 1999). Usually 50% or more of spawning adults have a total age of 5 years, with the remainder predominantly 4 year old fish (Murdoch and Miller 1999). In the past, sporadic reports of chinook spawning above Lake Osoyoos have been recorded during sockeye salmon spawning ground surveys. Spawning ground data In the Similkameen River indicate that summer chinook spawn from Enloe Dam to Driscoll Island, a total distance of 14 km.

Emergence timing probably occurs from January through April, although specific data on emergence studies was not identified in reviews for this LFA. Juveniles generally emigrate to the ocean as subyearling fry, leaving the Okanogan River from one to four months after emergence. However, there is evidence that some fish undergo an extended residence period, with a protracted downstream migration. Many subyearlings rear in the mid-Columbia impoundments for various periods of time during their outmigration (Peven and Duree 1997).

Steelhead Stock Status and Distribution in the Okanogan Watershed

Only summer-run steelhead utilize the Okanogan watershed. Winter-run steelhead were not known to ever use this system, likely owing to the long migration involved. The summer run steelhead of the Okanogan are considered part of the upper Columbia summer steelhead ESU, and were listed as endangered on August 18, 1997. Upper Columbia steelhead in the Okanogan are considered depressed according to SASSI (WDFW & WWTIT 1994). Although the historical record for steelhead in the Okanogan Watershed is not complete, Mullan et al. (1992) asserts that few steelhead historically used the Okanogan River. Salmon Creek historically supported self-sustaining steelhead runs, but lack of flow currently restricts access in most years. Some evidence suggests that steelhead may also have historically used other tributaries in the Okanogan Basin (Chapman et al. 1994b). Current habitat conditions in the Okanogan basin are generally poor to support most life history requirements of steelhead.

Although steelhead were probably never abundant in the Okanogan River due to natural habitat limitations, an estimated half of the steelhead production may have been lost as a result of fish access restrictions to Salmon Creek by irrigation water withdrawals (WDF and WDFW 1993). In 1955-56, the escapement estimate to the Okanogan was about 50 fish, from a total run size of about 97 fish (WDFW 1990). Assuming a 50 percent loss in production from Salmon Creek since 1916, the average run-size prior to the extensive hydroelectric development in the mid-Columbia River reach is believed to have been about 200 fish. The estimated total run-size of naturally produced summer steelhead to the Okanogan Subbasin declined to between 4 and 34 fish, from 1977 to 1988 (WDFW 1990).

Given that stock status at the sub-watershed level has not been definitively established in the Okanogan, describing the relative importance of specific steelhead stocks throughout the Okanogan watershed has great uncertainty. Nevertheless, 19 adult summer steelhead were trapped in Omak Creek in 2001 (C. Fisher, TAG). When considered against a total escapement to the entire system of between 4 to 34 fish from 1977 to 1988 (WDFW 1990), such populations, although small, become disproportionately important. Regardless whether the 2001 Omak Creek steelhead returns originated from earlier smolt transplants from the Wells Hatchery into the system, the creek may be especially important for the reestablishment/recovery of the summer-run steelhead ESU within the Okanogan watershed. Similarly, as indicated in the preceding paragraph, steelhead production from Salmon Creek was estimated to represent roughly 50% of the native production throughout the watershed prior to the erection of Conconully Dam. Finally, habitat in the upper Similkameen drainage, the largest tributary of the Okanogan basin, is restricted by Enloe Dam, approximately 8.5 mi from its confluence with the mainstem Okanogan. Although it has not been established that steelhead historically were able to ascend Enloe Falls, enhancements to the Similkameen, could benefit this species' recovery. Access to habitat above Enloe Falls would provide miles of suitable habitat for steelhead, in addition to benefiting chinook. Such an endeavor would need to consider potential species interactions with resident stocks upstream of Enloe Dam.

Sockeye Salmon

According to SASSI (1992), a "healthy" stock of sockeye salmon continues to use the Okanogan basin for spawning and rearing. The Okanogan sockeye are not currently listed under the ESA, but the population is limited by reduced rearing habitat in the North Basin of Lake Osoyoos (C. Fisher, TAG). Spawning population escapement estimates ranged from 20,202 to 34,679 fish in 1993, depending on the methodology used to calculate spawning population size (Hansen 1993).

Sockeye spawning in the Okanogan occurs in tributaries of Lake Osoyoos under high flow years, but predominantly in the mainstem of the Okanogan river, upstream of Lake Osoyoos. McIntyire Dam, 12.5 miles upstream of Lake Osoyoos, usually represents the upstream limit of spawning under typical flow years. Under high flow years sockeye may pass the dam and have been observed spawning up to Skaha Lake (Howie Wright, TAG). Spawning may occur as early as September 15, with timing tied tightly to water temperatures. Peak spawning activity in the Okanogan occurs at temperatures of approximately 11 degrees Celsius and lower (Hatch et al. 1993, as cited in Hansen 1993). In Hansen's study, approximately 58% of the spawning population was male and 42% female, 3,4 and 5 year old age classes represented. Four year old sockeye in the Okanogan spend either one or two years in freshwater residency before smoltification and sea-ward outmigration (Hansen 1993).

Resident Fish Species Stock Status and Distribution in the Okanogan Watershed

Important resident species in the Okanogan watershed include mountain whitefish (*Prosopium willamsoni*), rainbow trout (*O. mykiss*), westslope cutthroat trout (*O. clarki clarki*) and Pacific lamprey (*Entosphenus tridentatus*). Stock status and distribution of resident salmonids is not fully understood and was not a primary focus of this LFA, but a brief summary is provided here. Bull trout are documented to have used only Salmon Creek and Loup Loup Creek in the Okanogan basin. Historically, bull trout were reported in creel census records from the 1940s and 1950s in the north fork of Salmon Creek (Ken Williams, WDFW retired, personal communication to Nance Wells, TAG). The 'distinct population segment' (DPS) for bull trout, incorporating the entire Columbia (i.e., upper and lower), was listed as endangered on June 20, 1999. An assessment of bull trout stock status on a watershed basis is currently under preparation, however, no such assessments are provided in SASSI (WDF &WWTIT 1994).

Resident rainbow trout, cutthroat trout and non-native brook trout occupy many of the waters above the anadromous zone in the Okanogan watershed. Stock status of these species is not known; however, it has been thought that the non-native brook trout occupy waters otherwise suitable for bull trout (Okanogan TAG). The extent to which such introductions may have displaced bull trout cannot be determined.

Fish Passage

Dams

There are 21 dams in the U.S. portion of the Okanogan watershed: 9 state, 7 private, 3 federal, and 1 PUD (**Table 3-2**). There are 13 Vertical Drop Structures on the Canadian side (NMFS 2000). Zosel Dam (RM 78) controls the levels of Osoyoos Lake. Reconstruction work in 1987 improved fish passage into the lake.

A diversion dam on the mainstem Okanogan River above Oliver, B.C. is the upper terminus to migratory fish. The Similkameen River is impassable to all anadromous salmonids at Enloe Dam, an abandoned power generation facility approximately 8.5 miles above the mouth. It blocks access to more than 95% of the fish habitat potentially available in the Similkameen River. Diversions in Loup Loup, Salmon Creek and Antoine Creek, prevent the full use of the habitat potentially available in these systems. Recently there has been interest in relicensing the Enloe Dam, and fish passage alternatives are being investigated.

Table 3-2. Summary of Water Impoundment Rights in the Okanogan Basin (WDOE 1995)

Dam Name	Stream Name	Ownership	Year Completed	Dam Length	NID Height	Normal Storage	Max Storage
Fanchers Dam	Antoine Creek	Private	1926	450	68	500	600
Bonaparte Lake Dam	Bonaparte Creek	Private	1957	180	9	535	995
Stout Reservation Dam	Chiliwist Creek	Private	1958	250	25	18	24
Horse Spring Coulee Dam	Columbia River	Private	1924	650	67		7,000
Fish Lake Dam	Johnson Creek	State	1920	50	7	2,815	2,815
Schallow Lake Dam	Johnson Creek	State	1954	330	13	46	76
Osoyoos Lake Control Dam	Okanogan River	State	1986	321	40	1,700	55,000
Leader Lake Dam	Okanogan R & Tribs	Private	1910	300	53	5,900	6,750
Leader Lake Saddle Dam	Okanogan R & Tribs	Private	1910	650	11	1,000	1,850
Little Green Lake Dam	Okanogan R & Tribs	State	1959	88	11	400	730
Salmon Lake Dam	Okanogan R & Tribs	Federal	1921	1250	54	15,700	17,280
Sasse Reservoir Dam	Okanogan R & Tribs	State	1910	140	10	60	60
Spectacle Lake Dam	Okanogan R & Tribs	Federal	1969	1110	25	13,450	14,080
Whitestone Lake Dam	Okanogan R & Tribs	Private	1930	375	9	2,144	2,720
Conconully Dam	Salmon Creek	Federal	1910	1075	72	13,000	16,570
Enloe Dam	Similkameen River	PUD	1923	316	54	400	400
Blue Lake Dam	Similkameen R & Tribs	State	1923	1500	32	4,416	4,416
Sinlahekin Dam No. 1	Sinlahekin Creek	State	1949	180	14	175	333
Sinlahekin Dam No. 2	Sinlahekin Creek	State	1949	248	18	52	82
Sinlahekin Dam No. 3	Sinlahekin Creek	State	1950	285	9	304	593

Methodology For Developing Habitat Limiting Factors Assessments By Subwatershed In The Okanogan Watershed

This chapter summarizes the methods used to characterize the habitat and its limitations for salmon production in each of the Okanogan subwatersheds south of the U.S.-Canada border. Results from these assessments are provided in chapter 5 of this document. Habitat conditions in the Canadian waters of the Okanogan, approximately 60% of the total watershed area, are summarized in Appendix A. The subwatersheds of WRIA 49 within the United States include: Chiliwist Creek, Dan Canyon, Felix Creek, Duley Lakes, Salmon Creek, Omak Creek, Wanacut Creek, Johnson Creek, Tunk Creek, Chewiliken Creek, Aeneas Creek, Whitestone Creek, Bonaparte Creek, Siwash Creek, Antoine Creek, Tonasket Creek, Osoyoos Lake and Ninemile Creek. The subwatershed boundaries delineated for this LFA for both the U.S. and Canadian sub-watersheds are generally consistent with the USFS Hydrologic Unit Code (HUC) 5th field boundaries and with most of the subwatershed boundaries used in the Okanogan Watershed Water Quality Management Plan (OWC 2000). Sub-watershed maps, including fish distributions by species, are provided in Appendix B. At the end of each watershed section, a "Habitat Limiting Factors Assessment" is provided that describes how the current condition of the habitat affects salmonid performance within the watershed. The information presented in this chapter reflects field biologists' observations that may or may not have been published. The absence of information for a stream does not necessarily imply that the stream is in good "health" but may instead indicate a lack of available information. All references to River Miles (RM) are approximate, based upon map-wheel projections recorded from USGS topographic maps of the area (1:100,000), or GIS interpretations (where indicated). Uncertainties in the subbasin analyses, data gaps, and action item recommendations are summarized for each subwatershed in chapter 5.

Habitat Rating Criteria Adopted For The Okanogan Watershed

Identifying the extent to which a habitat factor may be limiting salmonid productivity requires a set of habitat rating criteria. These criteria can then be used to assess the functioning condition of selected habitat factors. In turn, this information can be used to promote an understanding of the relative significance of different habitat factors and allow for consistency in evaluating habitat conditions in each WRIA throughout the state.

Twelve habitat criteria most likely to affect salmonid productivity in WRIA 49 were selected by the Okanogan TAG as most applicable for rating habitat conditions on the basis of existing data. Habitat criteria represent those environmental conditions that best describe the relationship between biological performance and the environment (Mobrand Biometrics 1999). The National Marine Fisheries Service recognizes these criteria as "indicators" of habitat quality (NMFS 1996). The 12 habitat criteria selected by the TAG for evaluating habitat conditions in the Okanogan were: 1) dissolved oxygen, 2) temperature, 3) turbidity, 4) suspended sediment, 5) chemical contamination/nutrients, 6) fine sediment (substrate), 7) large woody debris, 8) percent pool, 9) fish passage, 10) change in peak or base flows, 11) riparian, and 12) streambank stability. These habitat attributes were grouped into five categories according to their relationship to the physical environment: 1) Water Quality; 2) In-Channel Habitat; 3) Habitat Access; 4) Flow; and 5) Channel Conditions. These categories are consistent with the "pathways" considered relevant to sustaining salmonid productivity by the NMFS (1996).

Numeric and/or narrative standards of several agencies have been developed for the habitat criteria selected by the Okanogan TAG, and these were reviewed for their applicability in rating salmonid habitat conditions in the Okanogan watershed (**Table 4-1**). It was decided to rate habitat conditions for each criterion as "good", "fair" or "poor" in accordance with numeric qualifiers for the 12 criteria (**Table 4-1**). For habitat criteria that had wide agreement on how to rate habitat condition, an accepted and appropriate standard for the ecoregion was adopted by the Okanogan TAG for the purpose of the assessment exercise. Where local conditions warranted deviation from rating standards developed elsewhere, alternate criteria were used. These ratings were not, and are not intended to be used as thresholds for regulatory purposes, but as a coarse screen to identify the most significant habitat limiting factors in the WRIA. They provide a level of consistency between WRIAs that allows habitat conditions to be compared across the state.

The following criteria in **Table 4-1** were selected by the Okanogan TAG as acceptable for rating habitat elements on a reach and/or sub-watershed level in the Okanogan watershed (WRIA 49). These criteria are to be applied (based on) reviews of existing data sources, or, alternatively from the combined professional expertise of the TAG where data is unavailable or where analysis of data has not been conducted. It is assumed that both the interpretation of existing data sources and the application of professional knowledge to sub-watershed ratings will require best professional judgement. When using these criteria in the assessment process, the user will clarify whether quantitative studies or published reports or qualitative, professional knowledge was used for rating the habitat factors.

Table 4-1. Salmonid Habitat Rating Criteria Adopted by the Okanogan TAG

Pathway	Habitat Factor (Indicator)	Source of Criteria	Parameter/Unit	Parameter Qualifiers	Channel Type	Poor	Fair	Good
Water Quality	Dissolved Oxygen (D.O.)	WAC173-201A	Measured as milligrams per liter in the water column.	Evaluate % saturation to reflect altitude & temperature effects on dissolved oxygen levels. There are only Class A waters in the watershed.	Class A waters	D.O. < 7.0 mg/l, and/or < 80% saturation	D.O. 7.0-8.0 mg/l, and/or between 80 and 90% saturation	D.O. > 8.0 mg/l, and/or > 95 % saturation
Water Quality	Temperature	WSP (= WAC 173-201A)	Degrees Fahrenheit, (Celsius in Parens.).	Assumes 7 day average temperature, not instantaneous measure. There are only Class A waters in the watershed.	Class A waters	$^{o}F \geq 75$ (23.9 ^{o}C)	$64.4 \leq {}^{o}F < 75$ ($18 \leq {}^{o}C < 23.9$)	< 64.4 ^{o}F (<18 ^{o}C)
Water Quality	Turbidity	Assorted authors, (see text)	Measured in nephelometric units (NTUs)	Could be assessed visually if hard data do not exist.	All waters in watershed	Greater than 100 NTUs for extended durations (> 48 hours continuous)	20 to 100 NTUs for extended durations.	Less than 20 NTUs for extended durations.
Water Quality	pH	WAC 173-201A	Measured on unitless scale of 1 to 14, with a neutral reading of 7	Measured instantaneously, using field probes, or anayzed under lab conditions. Values above 7 are alkaline, below 7 acidic.	All waters in the watershed	Below 5.5 or above 9, human caused variation greater than 0.5.	5.5-6.5 or 8.5 to 9, human caused variation less than 0.5.	6.5 to 8.5, no human caused variation less than 0.5.

Pathway	Habitat Factor (Indicator)	Source of Criteria	Parameter/Unit	Parameter Qualifiers	Channel Type	Poor	Fair	Good
Water Quality	Suspended Sediment	See Newcomb and Jensen 1996 (N. American Journal of Fisheries Mngt.).	Suspended sediment measured in mg/L. Clays: < 2 um Silts: 2 to < 50 um Sand: 50 to 2000 um. (Most suspended particles are between 0.1 to ~ 200 um).	Use appropriate effects threshold for evaluating suspended sediment data. Or, model effect of conc. & exposure duration (Newcomb & Jensen 1996).	All waters in watershed	Suspended sediment concentrations exceed relevant risk thresholds frequently (e.g., 1-2z/month, for extended durations)	Suspended sediment concentrations exceed relevant risk thresholds occasionally.	Suspended sediment concentrations and durations do not exceed relevant risk thresholds.
Water Quality	Chemical Contamination/ Nutrient Loading	a) Ecology pub. 97-14 (impaired and threatened surface waters requiring additional pollution controls) b) WAC 173-204 (Sediment Mngt. Standards) c) Summary of guidelines for contaminated freshwater sediments (WDOE 1995).	Generally measured in mg/l (ppm) or ug/l (ppb) for water criteria. Sediment criteria measured in mg/kg (ppm), ug/kg (ppb). Some criteria are normalized to (%) organic carbon. SMS criteria are for marine sediments, therefore other freshwater criteria [c] may be more applicable.		a) All waters in watershed/ subbasin/ reach	a) High levels of chemical contamination from agricultural and other sources. Greater than one 303(d) listing in sub-watershed (reach) b) Sediment quality does not meet SQC and currently exceeds other accepted freshwater effects thresholds (see c).	a) Moderate levels of chemical contamination from agricultural and other sources. One (1) 303(d) listing in sub-watershed (reach) b) Sediment quality currently meets SQC but has record of not meeting SQC or other accepted freshwater effects thresholds (see c).	a) Low levels of chemical contamination from agricultural and other sources. No 303(d) listings in the sub-watershed (reach) b)Sediment quality meets SQC and other freshwater effects thresholds (see c).
In-Channel Habitat	Fine Sediment (Sedimentation)	NMFS	Fines < 0.85 mm in spawning gravel	Measured preferentially by:	All waters in watershed	> 20%	12-20%	< 12%

Pathway	Habitat Factor (Indicator)	Source of Criteria	Parameter/Unit	Parameter Qualifiers	Channel Type	Poor	Fair	Good
			(criteria to be applied to lower gradient reaches only, where spawning might naturally occur [1-3% gradient])	(1) core sample, or (2) surficial embeddedness evaluation.				
In-Channel Habitat	Large Wood Debris (LWD)*	NMFS (originally derived from PACFISH)	Pieces/mile >12" dia., and >35' length	Overton et al. (1995) provide LWD loading stratified to channel type, width, and geology. TAG members are encouraged to consider these criteria when NMFS criteria appear inappropriate.	All waters in watershed	Less than 20 LWD pieces per mile, and riparian reserves lack sufficient recruitment potential.	Greater than 20 LWD pieces per river mile, but riparian reserves lack sufficient recruitment potential	Greater than 20 LWD pieces per mile with sufficient recruitment potential from riparian stand for continued functioning.
In-Channel Habitat	Percent Pool	WSP/WSA	% pool, by surface area	P1a = WSA pool definition	Waters of <2% gradient & <15m wide	< 40%	40-55%	> 55%
In-Channel Habitat	(con.)		% pool, by surface area	P1b = USFS pool definition	Waters of 2-5% gradient & <15m wide	< 30%	30-40%	> 40%
In-Channel Habitat	(con.)		% pool, by surface area	P1c = Colville tribe . P2 = Prof. Judgement	Waters of greater than 5% gradient, with bankfull width less than 15m	< 20%	20-30%	> 30%
Habitat Access	Fish Passage	NMFS (WDFW	Measure jump heights by inches, velocity in ft/seconds.	Passage restrictions will vary by species	All waters in watershed	Any artificial barriers present do not allow	Any artificial barriers present do not allow upstream and/or	Any artificial barriers present provide upstream

Pathway	Habitat Factor (Indicator)	Source of Criteria	Parameter/Unit	Parameter Qualifiers	Channel Type	Poor	Fair	Good
		SHEAR Program [WDFW 1997a,b] provides data on juvenile passage criteria)	Numeric criteria for passage through culverts from WDFW 1997b are found in the appendix to this document.	and between juvenile and adult stages.		upstream and/or downstream passage at all flows	downstream passage at low flows	and downstream passage at all flows
Flow	Resembles Natural Hydrograph	NMFS	Hydrograph change	Professional judgement required	All waters in watershed	Pronounced changes in peak flow, baseflow and/ or flow timing relative to an undisturbed reference watershed.	Some evidence of altered peak flow, baseflow and/or flow timing relative to an undisturbed reference watershed.	Watershed hydrograph indicates peak/ base flow and flow timing are comparable to an undisturbed reference watershed.
	Impervious Surface					Greater than 10% impervious surface.	From 3 to 10% impervious surface.	Less than 3% impervious surface.
Channel Condition	Riparian Vegetation	NMFS	A variety of metrics can be applied to address riparian condition. Interpretation should include aerial photograph and/or ground survey.			Riparian reserve system is fragmented, poorly connected, or provides inadequate protection of habitats and refugia for sensitive aquatic species (< 70% intact), and/or for grazing impacts:	There is a moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian reserve system, or incomplete protection of habitats and refugia for sensitive aquatic species (~70-80% intact), and/or for grazing impacts:	The riparian provides adequate shade, LWD recruitment, and habitat protection and connectivity in all areas, and buffers include known refugia for sensitive aquatic species (>80% intact),

Pathway	Habitat Factor (Indicator)	Source of Criteria	Parameter/Unit	Parameter Qualifiers	Channel Type	Poor	Fair	Good
						percent similarity of riparian vegetation to the potential natural community/ composition <25%	percent similarity of riparian vegetation to the potential natural community composition is 25to50% or better.	and/or grazing impacts: percent similarity of riparian veg. to the pot. natural community/comp is > 50%
Channel Condition	Streambank Stability	NMFS	% of banks not actively eroding		All	<80% stable (>200 ft?)	80-90% stable	>90% stable
Channel Condition	Floodplain Connectivity	NMFS			All	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wet-land extent drastically reduced and riparian vegetation/ succession altered significantly	Reduced linkage of wetland, floodplains, and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wet-land function, riparian vegetation/ succession	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession

NMFS = National Marine Fisheries Service, matrix of pathways and indicators, 1996

WSP = Wild Salmonid Policy (WDFW 1998)

WSA = Watershed Analysis (WDNR 1997)

WAC = Washington Administrative Code

*The TAG were unanimous in their discomfort with the LWD criteria indicated, but could not agree upon appropriate surrogate for the NMFS criteria indicated. Shrub-steppe habitats and arid conditions of the Okanogan cannot naturally achieve these loading conditions except in the most select locations in the watershed. Additional study is needed to define properly functioning wood loading conditions for Okanogan habitats. Loadings proposed by Overton et al. (1995) reflect channel type, width and flow from Idaho habitats perhaps more similar to those in the Okanogan. These wood loading conditions could represent a good starting point for initiating a study in the Okanogan region.

Role of Pathways and Indicators on Salmonid Health and Habitat

Water Quality.

A limited array of water quality parameters primarily dictate the suitability of aquatic habitats for salmonid fishes. The water quality indicators described below represent those considered most influential to salmonid health and habitat. In general, cool, well-oxygenated water is required. As stream temperatures rise, their dissolved oxygen content is reduced. Temperature increases and consequent reductions in bioavailable oxygen tend to have deleterious effects on fish and other organisms by: 1) inhibiting their growth and disrupting their metabolism; 2) amplifying the effects of toxic substances; 3) increasing susceptibility to diseases and pathogens; 4) encouraging an overgrowth of bacteria and algae which further consume available oxygen; 5) creating thermal barriers to fish passage, and 6) reducing available food organisms. In addition to temperature and dissolved oxygen, fine sediment, pH, nutrient loading, and toxicants can affect water quality to the point at which salmonid abundance and distribution are affected. The most common stream pollutants include nutrients such as nitrates and phosphates, fecal coliform bacteria, heavy metals (e.g. from mine wastes), and agricultural and industrial chemicals such as insecticides, herbicides, and petroleum-based hydrocarbons. The following discussion provides further detail on the water quality parameters of particular relevance to salmonid health and habitat in the Okanogan watershed.

Dissolved Oxygen

Dissolved oxygen is essential for fish survival. Requirements of salmonids vary by life stage, but are generally considered stressful to juvenile and adult salmonids at and below a concentration of approximately 5 mg/L, with lethality occurring at levels around 2-3mg/L. Growth rates may begin to be reduced at concentrations below 7 mg/L. Absolute requirements for dissolved oxygen in salmonids are greatest at the time of hatching (Alderdice et al. 1958). For example, it has been reported that Atlantic salmon eggs near hatching (at 10C) require dissolved oxygen levels of 7.5 mg/L, in comparison to post-hatch alevin (larval) requirements of 4.5 mg/L (Hays et al. 1951). Requirements in Pacific salmon will not substantively differ from those reported by Hays for the Atlantic salmon.

Dissolved oxygen saturation decreases with increasing temperature, altitude, and salinity. The absolute requirement for oxygen in fish is driven by the partial pressure differences between fish blood and the dissolved oxygen concentration in the water (Fisher 2000). Thus, fish use of dissolved oxygen is maximal and independent of environmental oxygen concentrations when the partial pressure of oxygen is sufficiently high. For steelhead and related salmonids, a minimum partial pressure of 118 mmHg in water is required to prevent hypoxia (Forteath 1988).

Temperature

This water quality indicator addresses high or low instream water temperatures that negatively affect salmonid migration or survival during any life history stage. Water temperature varies with time of day, season, and water depth. Although temperatures are particularly dependent on direct solar radiation, they are also influenced by water velocity, climate, elevation, location of stream in the watershed network, amount of streamside vegetation providing shade, water source, temperature and volume of groundwater input, the dimensions of the stream channel, and human impact. Water temperature strongly influences the composition of aquatic communities, with salmonids thriving or surviving only within a limited temperature range. Water temperatures of approximately 23-25°C (73-77°F) are lethal to salmon and steelhead (Theurer et al. 1985) and genetic abnormalities or mortality of salmonid eggs occurs above 11°C (51.8°F). .Physiological functions are commonly influenced by temperature, some behaviors are linked to temperature, and temperature is closely associated with many life cycle changes. Temperature indirectly influences oxygen solubility, nutrient availability, and the decomposition of organic matter; all of which affect the structure and function of biotic communities. As water warms, oxygen and nutrient availability decrease, whereas many physiological and material decomposition rates increase. These temperature-moderated processes can influence the spatial and temporal distribution of fish species and aquatic organisms (Bain and Stevenson 1999).

PH

The pH is a measure of the acidity of a solution and is reflective of the solute components dissolved within it. It is measured on a logarithmic scale such that a 1 point difference in pH reflects a 10-fold difference in acidity. Waters are considered acidic at pH values below 7 and alkaline at pH values above 7. As stated by Fisher (2000), "It (pH) is controlled by the carbonic acid cycle, the buffering capacity of the water, and the amount of carbon dioxide liberated into and out of the water via respiration and aeration, respectively in waters of inadequate buffering capacity, the production of carbon dioxide (from respiration) will drive the bicarbonate/ carbonate/carbonic acid cycle toward the production of carbonic acid, which will ultimately depress pH." Additional acidic contributions, such as nitric or sulphuric acid from acid precipitation, can also depress pH. At pH values below 5, aluminum, the most common element in the earth's crust, becomes bioavailable and toxic (Baker and Schofield 1982); other metals, in particular the divalent cations (e.g., copper) also become much more toxic at depressed pH values. In the Okanogan watershed, soil conditions are generally well buffered, and calcareous solutes generally result in alkaline waters. Indeed, waters in the region can be hyper-alkaline, exceeding conditions tolerated by salmonids (pH 9). At pH values in excess of 9, swimming can become erratic and blindness and/or mortality may result (Piper et al. 1982). Other constituents potentially found in surface waters such as ammonia become significantly more toxic at higher pH as their chemical equilibria shift towards unionized, bioavailable forms. Elevated pH coupled with high temperatures can be especially problematic in this regard.

Turbidity/Suspended Sediment

This water quality indicator addresses the potential impacts of turbidity and suspended sediments on fish health, behavior and food supply. As reviewed in Fisher (2000), sublethal effects of reduced growth, gill flaring, coughing, reduced prey capture efficiency and habitat displacement have been documented in salmonids at turbidities ranging from 20 to 265 nephelometric turbidity units (NTUs). These turbidity values would equate to suspended sediment concentrations of roughly 190 to 3,000 mg/L (Berg and Northcote 1985, Servizi 1988, Sigler 1988). Chronically elevated turbidities at and above approximately 20 NTUs can reduce the photosynthetic capacities of surface waters, ultimately depressing food supplies and feeding behaviors upon which salmonids directly depend (Gregory 1994).

A risk assessment methodology to address suspended sediment risks to aquatic biota has been recently completed that evaluates risks relative to exposure concentration, duration, particle size, and life stage sensitivity (Newcomb and Jensen 1996). As indicated by Newcomb and Jensen, specific tolerance values for suspended sediments vary greatly among fish species, salmonid life stage and particle size. This variation is largely reflective of the various environmental conditions under which salmonids are found in nature (e.g., glacial melt vs. spring fed streams). Within the Okanogan, no studies on salmonid tolerance levels to turbidity and suspended sediments have been conducted, therefore an interpretation of impacts to aquatic habitats from this water quality indicator is subject to the uncertainty inherent in the threshold criteria. A risk assessment paradigm may be needed to fully ascertain risks to salmonid production in the Okanogan watershed from turbidity and/or suspended sediment. The application of such a paradigm could be used to back-calculate acceptable sediment loading into sub-watersheds, and subsequently address land use practices responsible for sediment delivery. In the interim, unless specific water quality data were available, rating of this indicator at the sub-watershed/reach level was largely subjective and based upon visual observation of recurrent incidents of turbid waters.

Nutrient/Contaminant Loading

Nutrients can alter the trophic structure of aquatic systems by enriching aspects unfavorable to salmonids. High nitrate and phosphate loading can lead to eutrophication, choking fluvial systems with aquatic vegetation and subsequently affecting physical parameters such as dissolved oxygen and temperature that have direct physiological implications on salmonid health. Chemical contaminants may lead to sub-lethal or lethal consequences in salmonids through a variety of direct and indirect mechanisms (e.g., immunosuppression, behavioral alterations, reproductive disorders, etc.). Collectively and/or individually, these elements can limit or preclude the use of habitat otherwise suitable to salmonids for spawning or rearing.

In-Channel Habitat

This pathway considers habitat indicators of stream channel integrity that contribute to habitat complexity. These elements in turn translate to an increased potential for density dependent salmonid productivity.

Fine Sediment (Sedimentation atop substrate)

This habitat indicator was selected to evaluate the impacts of fine sediments on rearing and spawning habitat. Substrate refers to the mineral and organic material forming the bed of a stream channel or waterbody. The composition and size of the substrate determines the roughness of stream channels, and the roughness, in turn, has a large influence on channel hydraulics (e.g., water depth, width, and current velocity) of stream habitat. Clean gravel-sized substrates provide the micro-conditions needed by salmonids for effective spawning and rearing (Bjornn and Reiser 1991).

An increase in fine sediment recruitment into a stream channel above the rate of sediment transport out of the system can reduce pool depth, alter substrate composition, reduce interstitial space, and cause streambank instability through channel aggradation. Fine sediment particles that settle atop and into salmon redds during incubation reduce water exchange, thereby lowering the amount of oxygen available to the embryos, increasing the concentration of embryo wastes (toxic ammonia), and delaying the emergence of fry. Fry that manage to survive and emerge from such incubation environments are often smaller than fry incubated under optimal conditions, or they exhibit abnormalities (Emadi 1973). Rearing juvenile salmon and steelhead have also been observed to use the interstitial spaces between boulders in the substrate (interstitial space) for cover from predators and during low instream temperatures (50° F/10° C; Don Chapman Consultants 1989). A high percent of fine sediment in a stream channel can fill the interstitial spaces, eliminating such rearing habitat and contributing to a decreased survivability.

Roads can affect streams directly by accelerating erosion and sediment loading, by altering channel morphology, and by changing the runoff characteristics of watersheds. These changes can later affect physical processes in streams, leading to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition and stability of slopes adjacent to streams (Furniss et al. 1991). Sediment entering stream is delivered chiefly by mass soil movements and surface erosion processes (Swanson 1991). Failure of stream crossings, diversion of streams by roads, washout of road fills, and accelerated scour at culvert outlets are also important sources of sedimentation in streams within roaded watersheds (Furniss et al. 1991).

Large Woody Debris (LWD)

This habitat indicator addresses impacts resulting from the removal or the lack of LWD, and the decrease or the loss in LWD recruitment and/or recruitment potential. Large woody debris (LWD) provides important physical and biological functions in the wide variety of habitats used by all salmonids. Nelson (1998) states that the abundance of LWD is often associated with the abundance of salmonids and is thought to be the most important structural component of salmon habitat. The biological functions of LWD include predation and velocity refuge, and shade. The presence of LWD in the floodplain creates the diversity of habitat conditions that support multiple life stages of salmonids. LWD creates lateral channel migration and complexity. It sorts gravels, stores sediment and gravel, contributes to channel stabilization and energy dissipation and maintains floodplain connectivity. Large accumulations of LWD in the lower floodplain can direct flow into meander loops and result in formation of riverine ponds and other off-channel habitat features, providing for the recruitment of new LWD from these side channel areas. Large woody debris can also indirectly function as a formative factor in channel processes. When considering channel conditions in fish-bearing streams, the potential contribution or recruitment of LWD from non-fish-bearing tributaries is also an important factor. In small streams, LWD traps sediment, causes local bed and bank scour, and creates pools. Small channels are thus particularly dependent on in-channel woody debris structure for stability.

The anticipated location and size of LWD accumulations within a stream channel and its floodplain are a function of the stream’s hydrology, its physical characteristics (geomorphology) and the surrounding physical/vegetative environment. Size standards and properly functioning criteria recommended for LWD loading have varied between agencies, largely in reflection of the natural conditions where their management actions are focused. For example, large woody debris east of the Cascades has been described as wood material greater than 12 in diameter and 35 ft long (NMFS 1996). Such criteria are not particularly relevant in the shrub-steppe habitats that predominant in the lower elevations of the Okanogan watershed, and they have not been validated for even the upper portions of many of the watershed’s tributaries. In many locations, soil conditions and moisture are inadequate to achieve trees of this size, even in the absence of riparian disturbance (C. Nelson, TAG). For this reason, the TAG accepted the NMFS wood loading criteria for properly functioning conditions only by default (see Table 4-1 footnotes) and acknowledges that additional data are needed to accurately define natural potential wood loading conditions for the Okanogan watershed.

Percent Pool

Pools function to provide adult holding habitat, juvenile rearing habitat, and thermal refuge for both adults and juveniles. Pools are formed by the interaction of flow with solid and loose boundaries, such as LWD, boulders, bends, streambed and other flows (Nelson 1998). Pool formation primarily occurs during moderate to high flow events. The interaction of flow with these boundaries causes flow to converge and accelerate, increasing bed scour though increases in bed shear stress. Pools form around channel obstructions (i.e. boulders, bridge piers, culverts, LWD), at meander bends, and at tributary channel junctions (Nelson 1998). Sediment levels, LWD levels, and human-made channel obstructions can alter the pattern and frequency of pool development within the geologic and hydrologic confines of the channel. Pool area is a function of LWD and channel slope (Nelson 1991). Although there are several indices of pool quality, the areal estimate of ‘percent pool’ was selected by the TAG as the metric of pool quality which was the most appropriate given the paucity of data on pool conditions throughout the watershed, particularly in the sub-watersheds. Further investigations into the habitat conditions of Okanogan sub-watersheds could provide data on pool frequency and residual pool depth that will provide much needed information reflective of pool quality currently lacking.

Habitat Access

This pathway addresses the need to access existing habitat if salmonid production is to be maintained and enhanced. Throughout the historic range of the Salmonidae, barriers have been constructed that have restricted or prevented juvenile and adult fish from gaining access to formerly accessible spawning and rearing habitat. These barriers include dams and diversions with no passage facilities, culverts poorly installed or designed, and dikes that isolate floodplain off-channel habitat. Additional factors that can affect access include low stream flow or inhospitable temperature conditions that function as barriers during certain times of the year.

Changes in flow conditions can have a variety of effects on the accessibility to salmonid habitat; thus, evaluations of habitat access must also consider flow indicators (4.2.4). In general, spring spawning species (rainbow/steelhead) take advantage of high spring flows, accessing smaller tributaries, headwater streams and spring snowmelt-fed streams not accessible later in the year. Reproduction of late summer and fall-spawning species (spring chinook, summer chinook, and fluvial bull trout) occurs most frequently in alluvial reaches of larger streams and rivers where groundwater recharge strongly buffers local interstitial and surface water conditions from decreasing flows and increasing or decreasing water temperatures. Incubation of salmonid eggs and fry occurs within the interstitial spaces of gravels in the beds of cool, clean streams and rivers. Once emergence from the gravel is complete, young salmon are mobile, which increases their flexibility to cope with environmental variation by seeking suitable habitat conditions. Mobility is limited however, particularly for fry, so that suitable habitat and food resources must be available in proximity to spawning areas for successful first-year survival. Ideal rearing habitat affords low-velocity cover, a steady supply of small food particles, and refuge from larger predatory fishes, birds and mammals (Williams et al. 1996).

Flow

Stream flows are affected by the removal of surface waters for domestic, agricultural and municipal use, by groundwater withdrawals—particularly from shallow wells in direct connectivity with surface waters, and by impervious surfaces in a drainage basin that can alter groundwater recharge and surface water run-off rates. The impacts of reduced flows vary depending on a combination of fish use in the affected reach and the extent and duration of reduced flows. Decreased flows can reduce the availability of summer rearing habitat and contribute to temperature and access problems, while increased peak flows can scour or fill spawning redds. Other alterations to seasonal hydrology can strand fish or limit the availability of habitat at various life stages. Extended periods of low flows can delay the movement of adults into streams, draining their limited energy reserves, affecting upstream distribution and spawning success. High winter flows can cause egg mortalities by scouring and/or sedimentation of the spawning beds. Low winter flows can contribute to anchor ice formation and result in the freezing of eggs or stranding of fry. The overwinter survival of juvenile fish can be negatively affected by the reduction in the quantity and quality of winter rearing habitat as a result of low flows.

Stream flow is moderated by riparian vegetation as well as vegetative cover in the uplands. The removal of upland and riparian vegetation through timber harvest, road development, and through the conversion of land for agriculture and residential/urban use alters surface water runoff patterns and ground water storage patterns. Riparian areas, in particular, assist in regulating stream flow by intercepting rainfall, contributing to water infiltration, and using water via evapotranspiration. Plant roots increase soil permeability, and vegetation helps to trap water flowing on the surface, thereby aiding infiltration. Water stored in the subsurface sediments is later released to streams through subsurface flows. Through these processes, riparian and upland vegetation aid in moderating storm-related flows and reduce the magnitude of peak flows and the frequency of flooding.

Impervious Surface

This indicator reflects the impacts of impervious surfaces on the frequency and magnitude of high and low flows.

Resembles Natural Hydrograph

This habitat indicator addresses changes in peak or base flows and/or flow timing relative to what one would expect to see in an undisturbed watershed of similar area, geomorphology and climate (precipitation regime). The quantity of available water and the rate at which it reaches the stream channel and passes through the channel system are influenced by precipitation regimes, watershed size, vegetation cover, and certain topographic consideration (Swanston 1991). Altering the vegetative component of a watershed and diverting instream flows for out-of-stream uses can have a significant effect on the timing and magnitude of peak and low flows. Changes in percent cover, species composition, and/or stand age class can change interception, evapotranspiration and soil water retention rates. Timber harvest activities, conversion of land to agricultural and urban/residential use, and fire are all actions that have the potential to disturb the vegetative community of a drainage to the extent that there is a noticeable affect on the stream flow regime. High road densities, soil compaction associated with agricultural activities, timber harvest, and grazing all contribute to increased surface water runoff and decrease soil permeability and water retention. The diversion of instream flows have the potential to alter the magnitude and duration of low flows, affecting stream channel conditions and decreasing total wetted area.

Channel Condition

A stream channel represents the integration of physical processes occurring at the watershed level: hydrologic (i.e. precipitation, snow melt); erosional (i.e. debris flows); and tectonic processes (i.e. mass wasting events). The physical processes determine sediment, water, and LWD input to the channel. At the same time channel form or morphology is naturally constrained both laterally and vertically by valley form, riparian conditions and geology. The ability of the channel to transport and manage sediment, water and LWD is a function of the channel's morphology and roughness and the input of sediment and LWD (i.e . source, transport or response reaches; Montgomery and Buffington 1993). Channel form will change when any of these inputs are altered or when the channel is artificially confined or constrained.

Riprapping, originally installed for flood control, can reduce the river's ability to access its floodplain and migrate laterally, thereby dissipating high flow energy. Loss of floodplain access and opportunity for lateral channel migration can lead to channel downcutting that further reduces access to the floodplain (USFS Mainstem Wenatchee River Watershed Assessment

1999) and changes the sediment and LWD transport regimes of the river system. Riprapping and stream downcutting can also lead to accelerated bank erosion by diverting flow energies to opposite banks and weakening the toes of banks causing slumping.
Human land use activities within a watershed (i.e. road development, vegetation removal, water diversion) can alter the outcome of physical processes on channel formation and alter the ability of the channel to develop both laterally and vertically. For example, the quality and quantity of salmonid rearing and spawning habitat in a stream channel is controlled by the interaction of sediment and LWD with water and the transport of all three components through the channel network. Altering LWD levels or increasing sediment input can result in a decrease in the number and quality of pools, a decrease in the ability of the channel to retain sediment and organic matter, and an increasing width to depth ratio in low gradient reaches. Confining or constricting the stream channel can affect the rate and type of sediment, LWD, and water transport through the system. It is important to note that habitat conditions in fish-bearing streams are intimately influenced by contributions of sediment and LWD from non-fish-bearing streams within a watershed. In the Pacific Northwest, LWD has been found to have a significant influence on the formation of pools and channel form (Nelson 1998).

Agricultural practices and residential/urban development can also affect streams by accelerating erosion and sediment loading to streams and by changing the runoff characteristics of watersheds. Farmed fields left fallow (i.e. barren of vegetative cover) cause much surface erosion and sediment movement to streams as winter snow melts and runs off carrying soil into stream channels (Committee on Protection and Management of Pacific Northwest Anadromous Salmonids et al. 1996). This is particularly a problem where riparian vegetation has been removed and the land is farmed to the bank's edge. The conversion of riparian habitat to landscaped lawns has the same effect, removing bank stabilizing root mass thereby contributing to accelerated streambank erosion. Riparian vegetation naturally functions as a filter, captures sediment and buffers the flow of surface runoff into stream channels.

Riparian Vegetation

This channel condition indicator addresses factors that limit the ability of native riparian vegetation to provide shade, nutrients, bank stability, and a source for LWD into the active channel. Human impacts to riparian function include timber harvest, clearing for agriculture or development, and direct access of livestock to stream channels. The riparian ecosystem is a bridge between upland habitats and the aquatic environment and includes the land adjacent to streams that interacts with the aquatic environment. Riparian forest characteristics in ecologically healthy watersheds are strongly influenced by climate, channel geomorphology, and location of the channel in the drainage network. For example, fires, severe windstorms, and debris flows can dramatically alter riparian characteristics. The width of the riparian zone and the extent of the riparian zone's influence on the stream are strongly related to stream size and drainage basin morphology.

Riparian habitats include side channels which offer refuge from adverse winter conditions such as rain-on-snow events/flooding and icing, and often influence the water quality of adjacent aquatic systems. Riparian vegetation provides shade which shields the water from direct solar radiation thereby moderating extreme temperature fluctuations during summer and keeping streams from freezing during winter. Riparian vegetation helps stabilize banks by maintaining masses of living roots which reduce surface erosion, mass wasting of stream banks and consequently reducing sediment delivered to the stream channel (Platts 1991). Riparian vegetation also contributes to the recruitment of large woody debris (LWD). Large woody debris contributes to channel complexity, including pool development, and sediment storage. Riparian ecosystems act as reservoirs, storing run-off in soil spaces and wetland areas and diminishing erosive forces caused by high flow events. The presence of stream-side vegetation also reduces pollutants, such as phosphorous and nitrates through filtration and binding them to the soil. Riparian vegetation contributes nutrients to the stream channel from leaf litter and terrestrial insects, which fall into the water.

Riparian zones are impacted by all types of land use practices. Riparian forests can be completely removed, broken longitudinally by roads, and their widths can be reduced by land use practices. Further, species composition can be dramatically altered when native, old-growth, coniferous trees are harvested, allowing for the establishment of a younger seral stage of hardwood, deciduous tree species and young, smaller diameter conifers. Deciduous trees are typically of smaller diameter and shorter lived than coniferous species. They decompose faster than conifers so they do not persist as long in streams and are vulnerable to washing out from lower magnitude floods. Once impacted, the recovery of a riparian zone can take many decades as the forest cover reestablishes and matures and coniferous species colonize. In the more arid, narrower riparian zones common in the steep canyons of the lower Wenatchee basin watersheds, reestablishing conditions that support the regrowth of native riparian vegetation can be an even more difficult once the soil is disturbed.

Salmonids habitat requirements are met in part by healthy, functioning riparian habitat. For example: adequate stream flows must be present in order for fish to access and use pools and hiding cover provided by root wads and LWD positioned at the periphery of the stream channel. Microclimate, soil hydration, and groundwater influence stream flow; these factors are in turn influenced by riparian and upland vegetation. Vegetation and the humus layer intercept rainfall and surface flows. This moisture is later released in the form of humidity and gradual, metered outflow through groundwater where the geology supports the groundwater/surface water interaction. Through this process, stream flows may be maintained through periods of drought (Knutson and Naef 1997).

Streambank Stability

This channel condition indicator was selected to consider the role of the streambank in providing long-term stability to aquatic habitats needed by anadromous salmonids. Natural stream channel stability is achieved by allowing the river to develop a stable dimension, pattern, and profile such that over time, channel features are maintained and the stream system neither aggrades or degrades (Rosgen 1996; Leopold et al. 1992, Fluvial Processes in Geomorphology). For a stream to be stable it must be able to consistently transport its sediment load, both size and type (Rosgen 1996; Leopold et al. 1992). When the stream laterally migrates, but maintains its bankfull width and width/depth ratio, stability is achieved even though the river is considered to be an “active” and “dynamic” system (Rosgen 1996). Changes in discharge and sediment supply result in a limited number of possible channel adjustments, which vary with channel form and position within the stream network (Montgomery and Buffington 1993). Potential adjustments include changes in width, depth, velocity, slope, roughness and sediment size (Leopold et al. 1992). Channel instability occurs when, over a period of years, the scouring process leads to degradation (downcutting), or excessive sediment deposition results in aggradation.

Floodplain Connectivity.

This channel condition indicator was selected to evaluate the direct loss of aquatic habitat from human activities in floodplains (such as filling) and disconnection of main channels from floodplains with dikes, levees, and revetments. Disconnection can also result from channel degradation (downcutting) caused by changes in hydrology or sediment inputs. Floodplains are relatively flat areas adjacent to larger streams and rivers that are periodically inundated during high flows. In a natural state, they allow for the development of productive aquatic habitats through lateral movement of the main channel. Floodplains also provide storage for floodwaters, sediment, and large woody debris. Floodplains often contain numerous sloughs, side channels, and other features that provide important spawning habitat, rearing habitat, and refugia during high flows.

The alluvial fans of floodplains are an important feature of the floodplain, dissipating flow energy and maintaining and creating suitable rearing and spawning habitat over a wide range of flows. Large woody debris in a floodplain creates conditions necessary for plant colonization within an alluvial plain. Large woody debris is a primary determinant of channel morphology, forming pools, creating low velocity zones, regulating the transport of sediment, gravel, organic matter and nutrients and providing habitat and cover for fish (Bisson et al. 1987).

There are two major types of human impacts to floodplain functions. First, channels are disconnected from their floodplain laterally as a result of the construction of dikes and levees, which often occur simultaneously with the construction of roads, and longitudinally as a result of the construction of road crossings. Riparian forests are typically reduced or eliminated as levees and dikes are constructed. Channels can also form artificial high velocities as a result of downcutting and incision (degrading of riparian vegetation) of the channel if there is no good input of LWD, decreased sediment supplies, and increased high flow events. Reduced overbank flooding resulting from increased entrenchment can reduce groundwater recharge and alter the flow regime (Naiman et al. 1992, as cited in USFS Mainstem Wenatchee River Watershed Assessment 1999).

The second major type of impact to floodplains results from a loss of natural riparian and upland vegetation. Conversion of mature vegetated cover to impervious surfaces, early-mid seral deciduous riparian stands, pasture, and farmed fields has occurred as floodplains have been converted to urban/residential and agricultural uses. This has: 1) eliminated off-channel habitats such as sloughs and side channels, 2) increased flow velocity during flood events due to the constriction of the channel, 3) reduced subsurface flows, and 4) simplified channels since LWD is lost and channels are often straightened when levees are constructed.

Elimination of off-channel habitats can result in the loss of important rearing habitats for juvenile salmonids such as sloughs and backwaters that function as overwintering habitat for spring chinook, steelhead and bull trout. The loss of LWD from channels reduces the amount of rearing habitat available for juveniles. Disconnection of the stream channels from their floodplain due to levee and dike construction increases water velocities, which in turn increases scour of the streambed. Salmon that spawn in these areas may have reduced egg to fry survival due to the scour. Removal of riparian zones can increase stream temperatures in channels, which can stress both adult and juvenile salmon. Sufficiently high temperatures can increase mortality.

Fisheries Resources and Habitat Limiting Factors Ratings by Subwatershed

The following subbasin assessments evaluate subwatersheds where salmon or steelhead are known to occur, or where habitat conditions in the stream(s) have the potential to degrade habitat downstream, in salmonid-bearing waters. Ratings of “Good”, “Fair” or “Poor” were assigned during the assessment using the Okanogan Watershed Habitat Rating Criteria outlined in chapter 4, (**Table 4-1**). The information upon which the assessments were based was derived from published sources, technical reports and the combined professional knowledge of the TAG participants. Therefore, each rating incorporates how biologist(s) judged the quality of habitat for the various stream reaches from available information. The number “1” assigned to the rating indicates quantitative studies or published reports exist to support the rating. The number “2” assigned to the rating indicates the professional knowledge of the TAG was used to rate the condition and data analysis, data, or published reports were not available. Where “**DG**” (Data Gap) appears in the table, there was so little information available on the habitat condition (published or professional knowledge) that the TAG members did not feel confident making even a qualitative determination of condition for the habitat criteria. The absence of a stream on the list does not necessarily indicate salmon or steelhead do not occur in the stream or imply that the stream is in good (or poor) condition. Summaries of some subwatershed are highly truncated because they have not been documented to support salmon or steelhead, or they have not been surveyed. Where possible, reach breakdowns were incorporated into the rating schema, reflecting geomorphic constraints or other logical boundaries for evaluating habitat conditions within a subwatershed.

This chapter provides assessments of the habitat conditions and fisheries resources in the US sub-watersheds of the Okanogan watershed. Rankings of habitat indicators utilize the methodology and numeric and/or narrative standards outlined in Chapter 4. Reaches are delineated where possible. Drainage area, stream order classifications, river miles, and impervious surface area estimates for each of the Okanogan River sub-watersheds south of the U.S.-Canada border examined in this LFA are provided in **Tables 5-1** and **5-2**. Photographic representation of habitat conditions around the mouths of most of these sub-watersheds is provided in Appendix C.

Table 5-1 Area and tributary status of Okanogan River sub-watersheds

	Area (acres)	Tributary to:
Okanogan River – Interfluve	204,398	Columbia River
Nine Mile Creek	13,516	Okanogan River Interfluve
Tonasket Creek	37,874	Okanogan River Interfluve
Mosquito Creek[1]	6,093	Okanogan River Interfluve
Antoine Creek	46,690	Okanogan River Interfluve
Siwash Creek	31,032	Okanogan River Interfluve
Bonaparte Creek	97,877	Okanogan River Interfluve
Chewilken Creek	17,125	Okanogan River Interfluve
Tunk Creek	45,586	Okanogan River Interfluve
Wanacut Creek	12,595	Okanogan River Interfluve
Omak Creek	90,691	Okanogan River Interfluve
Chiliwist Creek	27,842	Okanogan River Interfluve
Loup Loup Creek	40,868	Okanogan River Interfluve
Tallant Creek[1]	9,832	Okanogan River Interfluve
Salmon Creek	98,625	Okanogan River Interfluve
Johnson Creek	28,694	Okanogan River Interfluve
Fish Lake Basin Area[1]	23,124	Self Contained Basin
North Fork Pine Creek[1]	23,841	Self Contained Basin
Aeneas Creek	6,890	Okanogan River Interfluve
Aeneas Lake[1]	21,246	Self Contained Basin
Whitestone Creek (Spectacle Lake)	27,333	Okanogan River Interfluve
Similkameen River	228,536	Okanogan River Interfluve

	Area (acres)	Tributary to:
Sinlahekin Creek[1]	189,521	Similkameen River
Wanacut Lake[1]	13,853	Self Contained Basin
Omak Lake	68,685	Self Contained Basin
Duley Lakes/Joseph Flats Area	51,319	Self Contained Basin
Swamp Creek	64,158	Columbia River
Columbia River Interfluve - East	139,955	Columbia River
Total	**1,667,798**	

1: included within spatial boundaries of sub-watershed listed above it for the LFA. To calculate total area of LFA sub-watershed the totals must be added (e.g., total Loup Loup area, with Tallant Creek drainage area is 40,868 + 9,832 acres = 50,700 acres).

Table 5-2 Stream order, river and road miles, and estimate of impervious surface area of Okanogan watershed sub-watersheds.

Sub-watershed	Stream Order	Mainstem of Sub-watershed River Miles[1]	Mainstem w/Tributary River Miles[1]	Total Sub-watershed River Miles[1,2]	Total Road Miles[1]	Total Road Miles[3]	Total Impervious Surface (acres)[1,4]	Percent Impervious Surface[5]
Chiliwist	2	3.7	19.3	34.5	108.4	69.2	420.6	1.5
Dan Canyon	3	5.5	21.6	30.1	33.9	19.5	131.6	
Felix Creek	2	2.6	6.0	62.4	56.8	64.8	220.1	6.5
Duley Lakes	0	0.0	0.0	0.0	70.5	34.1	273.5	0.5
Loup-Loup	4	16.8	62.0	93.9	141.3	107.1	548.0	1.1
Tallant Creek[6]	2	5.9	8.8	8.8				
Salmon	4	38.1	137.1	156.3	295.6	269.0	1146.7	1.2
Omak	4	22.4	155.4	273.8	264.6	183.4	1026.4	0.6
Wanacut	3	7.6	27.6	53.6	3.8	37.3	14.9	0.1
Tunk	3	3.7	67.5	76.4	96.5	87.6	374.2	0.8
Johnson	2	7.9	17.9	62.8	207.3	148.2	803.9	1.1
N/S Fk Pine Creek[6]	2	13.3	13.3	13.3				
Chewiliken	2	10.9	84.7	252.3	57.8	49.9	224.2	1.3
Bonaparte	4	24.1	117.6	126.1	202.5	152.5	785.5	0.8
Aeneas	2	8.0	23.8	26.9	39.8	31.6	154.3	0.5
Whitestone	2	2.8	25.9	83.4	162.5	142.6	630.3	2.3
Siwash	3	20.8	38.1	42.5	76.7	60.2	297.6	1.0
Antoine	3	16.6	54.0	55.1	94.5	103.9	366.5	0.8
Tonasket	3	7.3	41.0	74.7	130.9	173.3	507.6	1.2
Ninemile	2	6.8	11.4	13.8	21.1	26.3	81.9	0.6
Osoyoos Lake	0	0.0	0.0	3.8	25.9	14.7	100.4	
Similkameen River		20.56				199.1		
Sinlahekin River		23.47						

[1] Data from map-wheel projections of USGS 1:100,000 scale quadrangles. Each estimate performed three times. Coefficient of variation of estimates was less than 10%.

[2] Includes stream channels within sub-watershed area unconnected (at the surface) to the principal stream in the sub-watershed (e.g., Chiliwist Creek sub-watershed also includes the independent drainage Sullivan Creek).

[3] Golder, Associates GIS database of highway and county road measurements. High confidence in WSDOT highway interpretations, lower confidence in county road measurements.

4Average road width to calculate impervious surface estimate assumed to be 40ft. Estimate based on roads alone, and does not consider impervious surfaces created by buildings and other structures.

5 Calculated by dividing impervious surface acres by total sub-watershed acreage (see Table 5-1), and multiplying by 100.

[6] Considered within sub-basin boundary of adjacent watershed listed in directly above in Table.

Okanogan mainstem

Overview of Habitat Characteristics in Okanogan Mainstem

Mainstem conditions of the Okanogan watershed were described in detail in Section 2. The following discussion focuses specifically on the analysis of habitat factors within the mainstem that might limit anadromous salmonid production. For this analysis the mainstem Okanogan River was divided into four reaches. Reach one includes the extent of inundation from Wells Dam, from RM 0 – 17. Reach 2 runs from RM 17 to the outlet of Lake Osoyoos (RM 77.4). Reach 3 begins at the lower end of a series of large lakes (Lake Osoyoos), and ends at the current extent of anadromy at the base of McIntyre Dam (downstream of Vaseaux Lake). Reach 4 begins at the current extent of anadromy (McIntyre Dam), and ends at the historic extent of anadromy, the upper reaches of Okanogan Lake (RM).

Reach 1

Reach 1 of the Okanogan River is shaped by the Wells Dam on the Columbia River, which creates a lentic influence to the lowermost 17 miles of the Okanogan River for approximately 17 miles. Consequently, the majority of the reach is essentially an elongated pool. Water level fluctuates frequently due to operational changes (power generation, storage) at Wells Dam. The stream banks are rarely exposed to high energy flows and remain relatively intact, due to low gradient and storage influences. Substrate consists almost entirely of mud, silt, and sand. Riparian vegetation consists of a dense layer of shrubs and saplings, which further protect the banks from scouring and erosion. There are few mature trees.

Reach 2

Reach 2 is a broad, shallow, low gradient, channel with relatively homogenous habitat. There are few pools, and limited large woody debris. Sediment levels are high and substrate embeddedness is relatively widespread. There are highways on either side of the river for most of the length of Reach 2, and several communities along the river. Agricultural fields and residential areas are adjacent to the river.

Limiting Factors Assessment in Okanogan Mainstem Reaches

Table 5-3 Limiting Factors By Reach in Mainstem Okanogan River

Habitat Attribute and Indicator	*Reach 1 RM 0 - 17 confluence to upper end of inundation*	*Reach 2 RM 1 - 77.4 end of inundation to Lake Osoyoos outlet*	*Reach 3 RM 77.4 - Lake Osoyoos outlet to Ok Falls (current extent of anadromy)*	*Reach 4 RM - Oka Falls to historic extent of anadromy*
Water Quality				
Dissolved Oxygen	G1	F1		
Stream Temperature	F1	F1		
Turbidity/Suspended Sediment	G2	P2		
Nutrient Loading	P1	P1		
In Channel Habitat				
Fine Sediment (substrate)	P2	P2		
Large Woody Debris	P2	P2		
Percent Pool	G1	P2		

Habitat Attribute and Indicator	*Reach 1 RM 0 - 17 confluence to upper end of inundation*	*Reach 2 RM 1 - 77.4 end of inundation to Lake Osoyoos outlet*	*Reach 3 RM 77.4 - Lake Osoyoos outlet to Ok Falls (current extent of anadromy)*	*Reach 4 RM - Oka Falls to historic extent of anadromy*
Habitat Access				
Fish Passage	G1	G1	F2	P2
Stream Flow				
Resembles Natural Hydrograph	P2	P2	P2	P2
Impervious Surface	P2	P2	P2	
Stream Corridor				
Riparian Vegetation	P2	P2		
Stream Bank Stability	G2	F2		
Floodplain Connectivity	P2	P2		

Support for Limiting Habitat Factors Ratings in Mainstem Reaches

Water Quality

Reach 1

Dissolved oxygen (DO) was rated as Good in Reach 1. Data records from the WDOE monitoring site near the town of Monse, Washington, indicate adequate DO levels. Stream temperature was rated fair because the Okanogan River is on the WDOE 303d list for numerous water temperature measurements collected at Monse, which exceed Washington State water quality standards. Sediment sources along this reach are not extensive and relative to the rest of the basin considered good. The water level in Reach 1 is influenced by Wells Dam so high velocities are attenuated thus minimizing sediment input from stream banks. Reach 1 was rated poor for nutrient loading. The river is on the WDOE 303d list for fecal coliform, PCBs, and DDT. The presence of these toxins were found in fish tissues in a variety of data collections from 1983 through 1995.

Reach 2

The Okanogan River is on the State 303(d) list for dissolved oxygen, temperature, fecal coliform, and DDT based upon sampling conducted near the community of Okanogan, Washington. United States Geological Survey (USGS) collected water quality data near Malott, Washington. The instantaneous measurements were collected during the months of February, June, August, and October from 1990 – 1994. These data show late summer water temperatures in excess of 70^{o} F in each year from 1990 – 1993. More recently water temperatures were measured in excess of 83^{o}F (C. Fisher, Colville Confederate Tribes, unpublished data). Dissolved oxygen levels were always over 8 mg/L, and turbidity levels were always less than 25 NTUs. The river was rated Fair for DO and water temperature based on more current DOE data, and “poor” for nutrient loading. Turbidity was rated as “poor” based on observations (C. Fisher, Colville Confederated Tribes, personal communication). While five dams on the Okanogan River system act as sediment traps, the Okanogan River is still subject to elevated levels of suspended sediment during high spring flows and other rain events. (C. Fisher, Colville Confederated Tribes, personal communication).

Reach 3

Reach 4

In-Channel Habitat

Reach 1

The substrate in Reach 1 was rated "poor", as it is composed almost entirely fine sediments, silt, and mud (A. Murdoch, personal communication, 2001). Large woody debris (LWD) is virtually nonexistent in Reach 1 but rated "fair". However, although mature vegetation, mostly cottonwood, is limited along the banks of the Okanogan River, it is suspected all LWD deposited in the River would float and be carried downstream. Pool habitat was rated as fair due to the absence of hydrological complexity created by the influence Wells Dam. Pools in this reach are probably used by salmonids as holding areas during migration.

Reach 2

Reach 2 reach was rated "poor" for all three in-channel habitat attributes. Large woody debris and pool habitat are scarce, and fine sediments are abundant. Historic levels of woody debris and pool habitat are not known, but a low gradient system such as the Okanogan would accumulate large woody debris along the shoreline for extended periods of time.

Reach 3

Reach 4

Habitat Access

Reach 1

Reach 1 was rated "good" for habitat access as there are no barriers to fish passage.

Reach 2

Reach 2 was rated "good" for habitat access as there are no barriers to fish passage

Reach 3

Reach 3 was rated "poor" for habitat access. McIntyre Dam near the outlet of Vaseaux Lake is a barrier to migrating salmonids in virtually all years.

Reach 4

Reach 4 was rated "poor" for fish passage. At the outlet of Skaha Lake, a dam exists which provides added storage for irrigation and flood control. A fish way is incorporated at the structure but is not currently activated.

Stream Flow

Reach 1

Reach 1 does not resemble the natural hydrograph due to the influence of storage created by Wells Dam and consequently was rated "poor". Flow in this reach is dictated by operation of the dam. The reach was rated "fair" for impervious surfaces, as highways parallel the river on both sides in Reach 1. State highway 97 is periodically located within the floodplain on the east bank, and County Road 9155 lies beyond the floodplain on the west bank.

Reach 2

Stream flow in the Okanogan River, as well as most of the tributaries, has been altered for flood control, irrigation, and recreation activities. As a result the natural hydrograph has been severely altered and is rated “poor”. Impervious surfaces within the floodplain of the mainstem include State Highway 20, State Highway 97, and County Roads #9437 and #9320, as well as pavement in the communities of Malott, Okanogan, Omak, Riverside, Tonasket and Oroville. The reach was rated “poor” for this attribute.

Reach 3

Reach 4

Stream Corridor

Reach 1

Reach 1 was rated as “poor” for riparian vegetation due to the scarcity of mature tree species. Stream bank stability was rated “good”. A dense riparian shrub layer protects the bank from erosion, as does the attenuation of high flows caused by Wells Dam. Floodplain connectivity is “poor” due to the presence of Highway 97. In addition, in this reach the River is slightly entrenched and the control of the water level does not allow the channel to overflow its banks into the floodplain.

Reach 2

Riparian vegetation in Reach 2 was rated “poor”. As in Reach 1, the climax species and mature age classes are scarce. There is little recruitment of large woody debris. Streambank stability was rated “fair” in this reach due to areas of eroding banks, where exposed mineral soil is easily delivered to the River. Floodplain connectivity was rated “poor” because flood control measures (dikes, levees) have isolated the channel from its floodplain. Since the high volumes of water (flood flows) cannot disperse and dissipate energy laterally, the result is incision or eroding of the streambed. Channel incision further separates the river from the floodplain.

Reach 3

Reach 4

Chiliwist Creek Watershed

Sub-watershed Overview.

The Chiliwist Creek sub-watershed comprises approximately 27,842 acres, representing approximately 1.7% of the Okanogan watershed (OWC 2000). It is located in the southwestern corner of the Okanogan watershed, and is the lowest Okanogan sub-watershed upstream of the Columbia River confluence that drains lands from the west (Figure B-1). Chiliwist Creek enters the Okanogan River on its western side at approximately RM 15.1 (WDNR 1982). The sub-watershed includes all the habitat along the southeast border of the sub-watershed (i.e., the western shore of the mainstem Okanogan) for approximately 27 km (before entering the Columbia. The principal stream within this sub-watershed area is Chiliwist Creek, a second order tributary of the Okanogan. However, the sub-watershed also includes Sulivan Creek, Smith Lake, and Starzman Lake. None of these other waters within the sub-watershed regularly convey surface waters to the Okanogan.

Land Use and Ownership.

Forestry, livestock grazing, and irrigated agriculture are the primary uses of the Chiliwist sub-watershed (WDFW 1990). Forests account for roughly 61.6 percent of the basin (17,142 acres), rangeland comprises approximately 36.1 percent (10,053 acres), and the remaining lands are irrigated and non-irrigated cropland (632 acres) (OWC 2000). Apples are the main crop cultivated in the Chiliwist valley and lower Chiliwist Creek sub-watershed. The upper portion of the Chiliwist sub-watershed is part of the National Forest Service and offers a host of recreational activities, in addition to timber resources. The majority of the sub-watershed is owned by the Washington State Department of Natural Resources and the Washington Department of Fish and Wildlife.

Topography, Geology & Soils.

Glacial activity created the Chiliwist sub-watershed. The central portion of the sub-watershed forms a valley at approximately 500 ft that rises to 1000 ft around the western border of the sub-watershed. The Okanogan National Forest portion of the Chiliwist sub-watershed is part of the eastern slopes of the Cascade Range (LMEA 1997). Four mountains demarcate the sub-watershed's western and northern borders: Cook Mountain (1189 ft), Woody Mountain (1398 ft), Thrapp Mountain (1300 ft) and Dent Mountain (956 ft).

The lower Chiliwist sub-watershed is principally a quaternary alluvium with terrace deposits (USGS 1954). This strata is characterized by unconsolidated gravels, sand, silt and clay deposited by modern streams and by glacial melt. The central Chiliwist valley is principally composed of glacial till (granite, volcanic and sedimentary parent material) and bare bedrock. Within the Chiliwist Creek valley the bedrock surface is irregular and often exposed; however, unconsolidated glacial deposits overlying the bedrock may be up to 200 ft thick. In the upper portion of the basin above the Chiliwist valley the geology has been characterized as undifferentiated igneous and metamorphic rock which is generally non water bearing (USGS 1954).

Fluvial Geomorphology & In-Channel Habitat.

No formal studies were identified that quantified or otherwise characterized fluvial geomorphology or in-channel habitat conditions in the Chiliwist sub-watershed. The lower Chiliwist sub-watershed represents a small portion of the U-shaped unconfined alluvial valley through which the Okanogan River flows. The lower portion of the Okanogan River flows through sinuous, broad, low gradient channels depositing large accumulations of sediment into the alluvial fans of lower tributaries such as Chiliwist Creek (WDFW 1990).

Vegetation and Riparian Condition.

No formal studies were identified that quantified or otherwise characterized riparian condition in the Chiliwist sub-watershed. In the lower Chiliwist sub-watershed, along the Okanogan River, shrub/grass land dominate the plant community. Further upstream, in the Chiliwist valley, the soils and dry valley climate generate little vegetation and organic matter (WDFW 1990). Yellow pine and mountain alder dominates Okanogan National Forest lands in the upper basin.

Water Quantity/Hydrology

Surface Water

No gauges operating on Chiliwist Creek or Sullivan Creeks were identified in the review process for this LFA. During much of the growing season all surficial flows from lower Chiliwist Creek are diverted for irrigation (Walters 1974). Within and downstream of the Chiliwist valley the flow in Chiliwist Creek becomes erratic and often subterranean. Surface flows measured sporadically in Chiliwist Creek between 1968 and 1970 ranged from 0.55 to 0.59 cfs in the upper basin above the Chiliwist valley (near center sec. 14, T. 32 N., R. 24 E; n = 5), 0.6 to 1.16 cfs in the mid-basin (NE ¼ SW ¼ sec.13, T. 32 N., R. 24 E.; n = 6) and 0.75 to 3.30 cfs (SE ¼ SE ¼ sec. 18, T. 32 N., R. 25 E., n = 4) under highway 97 approximately 0.5 km from the mouth (Walters 1974). Recent monthly measurements conducted by the Okanogan Conservation District between May and December of 2000 recorded a range of 0.037 to 0.987 cfs in the upper Chiliwist basin, and a range of 1.27 to 8.488 in the lower basin (T. Neslen, TAG, OCD unpublished data). These latter data represent the first year's results from a 3-year monitoring program recently undertaken by the OCD.

Much of Chiliwist creek downstream of the Chiliwist valley has been channelized, and flows have been directed through at least a dozen culverts (Figure B-1). There are at least five irrigation diversion dams in lower Chiliwist, downstream of the valley (www.streamnet.com).

No information on surface flows in Sullivan creek was reviewed for this LFA. This creek flows into the Chiliwist valley and then becomes subterranean. The contributions of this creek to recharging the valley aquifer and supplementing flows in lower Chiliwist Creek are not known.

Groundwater

Pumping records from 1969 recorded 80 million gallons (250 acre-feet) of groundwater withdrawn for irrigation for all land use (Walters 1974). Deep unconsolidated deposits within the Chiliwist valley may yield up to 300 gallons per minute of flow and the combined Chiliwist-Loup-Loup sub-watersheds were estimated to store approximately 35,000 acre-feet of water (Walters 1974). Current pumping records were not reviewed for this LFA.

The relationship between surface flows and groundwater recharge has not been formally investigated in Chiliwist Creek. According to MWG et al. 1995), there are 21 permitted surface water rights for a total withdrawal of 11.8 cfs (2,688 ac-ft/yr). There are an additional 66 surface water claims for 5.6 cfs (1,006 ac-ft/yr). There are 2 groundwater permits (560 gpm) and 11 additional groundwater claims (99 gpm).

Water Quality.

Historic data on conventional water quality or chemical pollutants in the Chiliwist sub-watershed were not identified. The Okanogan Conservation District (T. Neslen, TAG, unpublished OCD data) has conducted recent conventional water quality monitoring in upper and lower Chiliwist Creek. In monthly monitoring between mid-May and early July of 2000 in the upper Chiliwist, dissolved oxygen concentrations appear to be at or near saturation, ranging from 9.35 to 10.71 mg/L. The pH of the upper basin's surface waters in this period were alkaline, ranging from 8.34 to 9. Turbidity was low, ranging from 1.2 to 9.32 NTUs. Temperatures ranged from 14.2 to 15.5 degrees Celsius. Subsequent monitoring in the upper basin through the duration of the year could not be performed due to lack of flow.

In the lower Chiliwist basin, where flows permitted monthly monitoring through hydrologic year 2000, the OCD measured dissolved oxygen values between 9.86 and 14.53 mg/L, pH values of 8.35 to 8.92, turbidity ranging from 2.37 to 5.1 NTUs, temperatures of 1.4 to 14.5, and conductivity of 54 to 411 uS/cm (T. Neslen, TAG, unpublished OCD data). As expected, temperatures were highest and dissolved oxygen was lowest in August. These values are all within a range acceptable by salmonids for rearing and other life stage functions.

Data on nutrients and/or contaminants in the Chiliwist surface or groundwaters were not identified in review efforts for this LFA.

Fisheries Resources in Chiliwist Creek Sub-watershed

Only about the lower ½ mile of Chiliwist Creek is accessible to anadromous salmonids (**Figure B-1**) because a natural gradient barrier likely prevents further access upstream (Okanogan TAG). The use of this area for juvenile rearing or refuge by chinook, steelhead and sockeye has not been formally determined. However, water quality in the lower basin would not preclude its use by any of the salmonid species in the basin for these functions. The cooler waters found within this tributary relative to the mainstem Okanogan suggest that it may be important in providing thermal staging during summer migrations of adult chinook, steelhead and sockeye, with permissible flows.

Sockeye salmon do not use the Chiliwist sub-watershed for spawning. No data are available on the use of Chiliwist Creek for spawning by steelhead, but it is very unlikely given the low run size in the Okanogan River, and the limited use of more suitable habitat elsewhere in the Okanogan watershed. Summer chinook do not spawn in the Chiliwist sub-watershed; the current chinook run spawn upstream of Mallott (Okanogan RM 16.9) to Zosel Dam (RM 78), with the majority near the confluence of Omak creek, and in the Similkameen region by the town of Oroville. Thus, no chinook redds were found in the Chiliwist sub-watershed, or mainstem portions of the Okanogan river downstream from the Chiliwist confluence in 1998 ground and aerial surveys (Murdoch and Miller 1999). The mainstem Okanogan River downstream of the Chiliwist Creek confluence is inundated with backwater from the Wells Dam hydroelectric project and therefore offers unsuitable habitat for mainstem spawning of all salmonid species.

Rankings of Habitat Limiting Factors in the Chiliwist Sub-watershed

Habitat condition ratings of the Chiliwist sub-watershed are provided in **Table 5-4**. The numeric standards used to evaluate existing habitat literature and/or professional judgment from the Chiliwist subbasin are provided in **Table 5-4**. Two reaches were considered for habitat ranking, an upper Chiliwist reach above the anadromous zone, and a lower Chiliwist reach, including all waters downstream of the first anadromous barrier in the system at approximately RM 0.5 from the Okanogan confluence.

Water Quality

With the exception of information on chemical contamination and nutrients, current information on the conventional water quality parameters known to affect fish health and distribution are favorable for salmonids. For this reason, the indicators of dissolved oxygen, turbidity and temperature were rated as “good” in both the upper and lower reaches of Chiliwist Creek. The pH values measured to date by the OCD are moderately alkaline and occasionally above the values considered good. pH values have not, however, exceeded 9.0. Thus, pH was ranked as “fair”. Chemical contamination and nutrient impacts in the sub-watershed are not known, and are therefore indicated as data gaps for both reaches. Additional monitoring data forthcoming in 2002 and 2003 could alter these ratings; however, the standard deviation of the near-monthly measurements collected to date were minimal.

Table 5-4: Chiliwist Creek Limiting Factors Assessment

Habitat Pathway and Indicator*	Limiting Habitat Factor Ranking Reach 1—Lower Chiliwist (RM 0-0.5)	Limiting Habitat Factor Ranking Reach 2—Upper Chiliwist
Water Quality		
Dissolved Oxygen	G1	G1
Stream Temperature	G1	G1
pH	F1	F1
Turbidity/Suspended Sediment	G1	G1
Chemical Contamination/ Nutrient Loading	DG	DG
In Channel Habitat		
Fine Sediment (substrate)	DG	DG
Large Woody Debris	DG	DG
Percent Pool by Area	DG	DG
Habitat Access		
Fish Passage	G2	DG
Stream Flow		
Resembles Natural Hydrograph	P1	P1
Impervious Surface	F1	F1
Stream Corridor		
Riparian Vegetation	DG	DG
Stream Bank Stability	DG	DG
Floodplain Connectivity	DG	DG

Support for Limiting Habitat Factor Rankings in Chiliwist Creek Sub-watershed

In-Channel Habitat

Because no formal habitat studies have been conducted in the Chiliwist basin, in-channel habitat conditions could not be rated, and the indicators of habitat pathways considered for this LFA were listed as ‘data gaps’.

Habitat Access

Below the dam at RM 0.5 there are no passage barriers recognized, hence, the lower Chiliwist reach received a rating of good. The passage barrier at river mile 0.5 remains to be officially investigated and it is not known whether some flow conditions in the creek might pass anadromous fish. Data from Streamnet reveal numerous culverts and diversions in the upper Chiliwist sub-watershed (Figure B-1). These water manipulations have not been formally evaluated, to our knowledge, for their ability to pass fish. For this reason, it was conservatively assumed that fish migrations within the upper basin may be compromised, as historic culvert placements did not regard juvenile fish passage criteria. Since data have not been fully evaluated, however, a ranking of F was supported. A qualifier of ½ indicates both data and professional judgement were considered in the ranking.

Stream Flow

Upstream water withdrawals allocate all surface flows from this drainage, thereby affecting potential rearing of all fish species over the entire basin area downstream of the withdrawals. While natural conditions also contribute to dewatering, current data support the rankings of poor for streamflow indicators (normal hydrograph) in both the upper and lower reach.

Estimates of impervious surface area (Table 5.1) indicate a 'fair' rating based upon numeric qualifiers provided in Table 4.1

Floodplain Connectivity

No data are available with which to evaluate the functionality of floodplain indicators relative to the numeric and narrative qualifiers of Table 4.1. For this reason, the indicators of floodplain connectivity in both the upper and lower reaches of Chiliwist Creek were listed as 'data gaps'.

Indian Dan Canyon Watershed Description

Sub-watershed Overview

Dan Canyon is an intermittent, third-order tributary to the Okanogan River located entirely on the southwest plateau of the Colville Indian Reservation (Figure B-2). The southwest plateau also incorporates the Duley Lakes and Felix Creek sub-watersheds that have been delineated for this LFA. The Dan Canyon sub-watershed covers 9,081 acres and drains to the west. Dan Canyon enters the eastern side of the Okanogan River at approximately RM 5, although surface flows from Dan Canyon rarely (if ever) reach the Okanogan River. The watershed is a dense network of small, Type 4 and 5 intermittent streams, with a total stream length of 40.4 miles.

Land Use and Ownership

Rangeland, and crop production are the primary land uses in Dan Canyon (CCT 2001). No data were reviewed to provide a more refined percentage breakdown of land use activities. Dan Canyon drains lands owned entirely by the Confederated Tribes of the Colville Reservation.

Topography, Geology and Soils

Dan Canyon is part of the southwest plateau portion of the Colville Reservation that also includes the Felix Creek and Duley Lakes sub-watersheds. The sub-watershed's elevation ranges from 820 feet at the Okanogan River confluence to 2,620 feet (USGS 1954, CCT 2001). From the river, slopes rise moderately until leveling out at the top of the southwestern plateau. The plateau is an area of mid-elevation rangeland located in the southern portion of the Colville Reservation.

The upper portion of the sub-watershed is composed of undifferentiated igneous and metamorphic rocks with low water bearing potential (USGS 1954), and the lower portion of the basin adjacent to the river is comprised principally of a quaternary alluvium with terrace deposits. The plateau area is composed chiefly of range soils formed in basaltic glacial till and material weathered from basalt, with a mantle or component of loess. Most soils in the northwest part of the plateau escarpment derive from glacial till, weathered granite, and loess. Soils were principally formed in glacial outwash and eolian sand with a component of loess occur at lower elevations on terraces, terrace escarpments, and dunes, along the Columbia and Okanogan Rivers. Most of the area was glaciated over a layer of basalt, which probably accounts for the many isolated lakes (CCT 1997). Soil erosion potential is low.

Fluvial Geomorphology & In-Channel Habitat

No quantitative or qualitative studies on channel morphology and habitat were found in reviews conducted for this LFA. Moderate to low channel gradients (0-10%) prevail in the lower basin. Channel complexity is likely low due to the sparse tree layer naturally available to recruit wood (large or small) into the stream network. Intensive grazing pressure in the sub-watershed may have exacerbated this situation. The potential may exist for off-channel habitat at the confluence of Dan Canyon, although this has not been confirmed.

Vegetation and Riparian Habitat

No quantitative or qualitative studies have been conducted on the vegetative communities in the Dan Canyon sub-watershed. Sagebrush-steppe probably dominated the area historically. Riparian areas were historically dominated by deciduous vegetation (cottonwood and willow), with a very minor conifer component at the uppermost elevations. Presently, the area is heavily grazed (CCT 1997).

Water Quantity/Hydrology

A series of potholes dotting the landscape along the upper (eastern) margin of the Dan Canyon sub-watershed are the principal water sources in the sub-watershed. No formal studies have been conducted to determine the storage capacity of these waters, or to ascertain the link between groundwater and surface water flows. These potholes are fed by intermittent streams and groundwater, and hold water seasonally or year-round. The potholes may recharge groundwater that is ultimately conveyed towards the Okanogan River as Dan Canyon surface water, however, this scenario has not been confirmed with field study. Most of the plateau does not have surface flows to the Okanogan River.

There are no surface water permits in Indian Dan Canyon, but 20 surface water claims that could account for a withdrawal of 1 cfs (158 ac-ft/yr) (MWG et al. 1995).

Water Quality

No studies were identified for this LFA that formally documented water quality in Dan Canyon's lentic or lotic waters. They are generally known to be highly alkaline, with high summer temperatures generally outside of the range acceptable to salmonids (CCT 2001).

Fisheries Resources in Dan Canyon Sub-watershed

Fish presence in this area is minimal, as most streams are intermittent, and most lakes are highly alkaline or saline. Productivity in the pothole lakes is limited currently and historically by the alkaline waters condition, high water temperatures, and the fact that most of the lakes have no outlet, so no flushing can occur (CCT 2001). There are no anadromous species in the streams of the southwest plateau, including Dan Canyon (**Figure B-2**). There is no historical information on fish presence, but anecdotal reports suggest that the creek may never have supported fish (CCT 2001).

The Colville Tribe used the Unified Watershed Assessment Categories (UWAC), a part of the EPA Clean Water Action Plan Criteria (EPA 1998) to characterize the condition of the watersheds on the reservation. Dan Canyon received a Category I rating, indicating that the sub-watershed does not meet clean water and other natural resource goals, and needs restoration. This rating was based on general knowledge of the area, and should be field checked (CCT 2001).

Habitat Limiting Factors Assessment of the Dan Canyon Sub-watershed

No assessment was done, as there are no anadromous fish presently or historically in Dan Canyon. Dan Canyon rarely if ever has an impact on the Okanogan River, because its flow does not reach the river. The primary habitat concern in Dan Canyon is flow alteration caused by natural conditions, agricultural practices and the road construction.

Loup-Loup Watershed Description

Subwatershed Overview

Loup Loup Creek enters the Okanogan River at RM 16.9, in the small community of Malott, WA (**Figure B-3**). Nearly the entire watershed (40,868 acres) is categorized as forested (86.5%). Peak elevation in the sub-watershed is approximately 6,100 feet (Buck Mt.), with several other peaks nearing 5,000 ft. Land ownership includes the Bureau of Land Management (BLM), Washington Department of Natural Resources (WDNR), United States Forest Service (USFS) and private owners, with WDNR responsible for managing 31,506 acres.

Land Use and Ownership

The Loup Loup Creek watershed (40,868 acres) contains a variety of land uses including forestry, rangeland, non-irrigated pasture, irrigated orchard, urban and open water. However, the majority of the land use is forest (86.5%). Land ownership is primarily privately owned and managed by the Washington Department of Natural Resources (31,506 acres (C. Dibble personal communication). However, there are smaller parcels of public land managed by the Bureau of Land Management (BLM) and United States Forest Service (USFS).

Included in this watershed is the unincorporated community of Malott, Washington located adjacent to the confluence of Loup Loup Creek and the Okanogan River. According to the 2000 census the population of the voting precinct is 712 and approximately 83 within the city limits (T. Murray personal communication). The lowermost area of the watershed is primarily urban development and orchards. The mid-range area of the watershed consists of range land-type and the uppermost is forested. Two lakes, Leader and Buzzard, are destination points in the watershed with the former noted for trout fishing.

Water Quantity/Hydrology

Waters in Loup Loup creek and the sub-watershed are heavily diverted and used for irrigation. There are a total 3 groundwater permits and 5 groundwater claims. The permits specify a total withdrawal of 350 gpm (18-acre-ft/yr) while the claims could support a withdrawal of 45 gpm (MWG et al. 1995). Surface water withdrawals permitted account for only 0.1 cfs, but claims amount to 2,366.9 cfs (473,168 ac-ft/yr). The system is over allocated and is usually dry in its lower reaches in the summer, preventing its use by salmonids.

Fisheries Resources in Loup Loup Creek Sub-watershed

Historically, cutthroat trout likely existed in the upper reaches of Loup Loup Creek, and reliable anecdotal evidence of bull trout presence in the upper drainage reaches have also been reported (K. Williams, WDFS [retired], personal communication to N. Wells [Okanogan TAG]). Anadromous and resident forms of rainbow trout existed in Loup Loup Creek. The anadromous forms of rainbow trout (i.e. steelhead) migrated as far as the falls (approximately RM 2.5) (**Figure B-3**). Currently fish species in Loup Loup Creek include rainbow trout and brook trout. The rainbow trout are likely remnants of a historical anadromous form. Eastern brook trout were planted by the Washington Department of Fish & Wildlife and have either hybridized or out-competed the native bull trout. Today, the range of anadromous fish in Loup Loup Creek is limited by man-made fish passage barriers and discontinuous flows. The lowermost barrier is a perched culvert at approximately RM .1. At ~ RM 2.0 water is diverted for irrigation. Typically the lower reach becomes dry during early summer (June/July), thus voiding all possible natural reproduction.

Leader Lake in the Loup Loup sub-watershed is a popular recreational sport fishery. Washington Department of Fish and Wildlife (WDFW) stock the Lake annually with 25,000 rainbow trout fry. During 1998 the WDFW rehabilitated Leader Lake to remove largemouth bass introduced by an unauthorized planting. Species known to exist in the upper reaches of the basin include rainbow and brook trout. There have been accounts of large fish utilizing the lower reaches of Loup Loup Creek and are presumed to be steelhead.

Habitat Limiting Factors Assessment for Loup Loup Sub-watershed

For this analysis two reaches were evaluated in Loup Loup Creek (**Table 5-5**). The lower reach extends from the confluence with the Okanogan mainstem to the base of a pair of falls approximately 12 feet high at ~ RM 2.5. These falls were likely the extent of the historical range of steelhead in Loup Loup Creek. The upper reach extends from the falls to the headwaters of Loup Loup Creek. The source of habitat and water quality information provided for this analysis of Loup Loup Creek was from reconnaissance-level surveys by the Colville Confederated Tribes Fish and Wildlife staff, data collection by Okanogan Conservation District (T. Neslen, OCD [Okanogan TAG]), or personal communication with Ken Williams, formerly regional fish biologist for Washington Department of Fish and Wildlife.

Table 5-5: Loup-Loup Creek Habitat Limiting Factors Assessment Rating

Habitat Pathway and Indicator*	Limiting Habitat Factor Rankings--Reach 1 RM 0 to 2.5	Limiting Habitat Factor Rankings--Reach 2 RM 2.5 to 19.8
Water Quality		
Dissolved Oxygen	G1	G1
Stream Temperature	G1	G1
Turbidity/Suspended Sediment	F2	G1
pH	F1	G1
Chemical Contamination/Nutrient Loading	P1**	G1
In Channel Habitat		
Fine Sediment (substrate)	F2	DG
Large Woody Debris	P2	DG
Percent Pool	P2	DG
Habitat Access		
Fish Passage	P1	DG
Stream Flow		
Resembles Natural Hydrograph	P1	P1
Impervious Surface	G2	G2
Stream Corridor		
Riparian Vegetation	F2	F2
Stream Bank Stability	F2	F2
Floodplain Connectivity	F2	G2

*pathways are emboldened, indicators in plain type
**Due to Tallant Creek DDT water quality exceedance

Water Quality

Reach 1

Water quality data were provided by the Okanogan Conservation District from their ongoing monitoring of Okanogan tributary monitoring. The data were collected at monthly intervals from May 17 through July 5, 2000 and from January 17 to May 16, 2001. From August 9 through December 20, 2000 the lower reach of Loup Loup Creek was dry, which therefore prevented rating all water quality indicators at that time. Thus, as with all sub-watershed assessments, ratings were performed on the basis of the existing data alone. (Flow limitations are reflected in the ranking of the streamflow criteria).

When flows were present, dissolved oxygen averaged 11.05 mg/L and ranged from 9.79 to 13.79 mg/l. Thus, this indicator was rated good in reach 1.

Water temperature was never recorded above 58.1^{o} F. However, flows were discontinued in this reach by August 9, 2000, when elevated water temperatures could possibly occur. However, data which do not exist could not be rated. Thus, temperature received a rating of good, based on the existing data.

Turbidity was evaluated 8 times during the period from May 17, 2000 to May 16, 2001. NTUs's varied from 0.3 to 5.69. These measurements all fall within the good range adopted for rating this habitat indicator by the Okanogan TAG. Reduced flows during typical peak spring runoff may be the reason for reduced turbidity found in the lower reaches of this stream. Furthermore, total suspended solids have exceeded 144 mg/L for 4 of 7 measurements taken by the OCD. These higher recordings were measured when flows continued after a 5-month absence. The higher total dissolved solid measurements could possibly be attributed to increased levels of calcium carbonate due to the discontinuation of flow during the previous 5 months (T. Neslen personal communication). These collective data support a rating of fair, based on professional opinion.

The pH in reach 1 in monitoring conducted to date has routinely exceeded 8.5 (range 8.19 –8.84, average 8.59). Thus, this habitat indicator was rated as fair.

Tallant Creek is a small, perennial independent tributary within the boundaries of the Loup Loup sub-watershed area that also conveys surface waters to the Okanogan River (Figure B-3). The use of Tallant Creek by anadromous salmonids is not known, but thought minimal, if used at all. If habitat is used, it is that near the confluence, hence, it is described within Reach 1 of the Loup Loup drainage. Notwithstanding, the Washington Department of Ecology conducted a 1995 study to assess DDT in tributaries in the Okanogan River (Johnson et al., 1997) and found concentrations substantially exceeded the state's chronic surface water quality standard of 0.001 ug/L (parts per billion) in Tallant Creek (range: 0.19 – 0.50). These levels also exceed concentrations found in other drainages where DDT was historically applied. Currently the Washington Department of Ecology is sampling for DDT and PCBs throughout the Okanogan River watershed to better identify sources. This sampling is part of a TMDL investigation for the Okanogan River.

Reach 2

Water quality measurements, in the upper reach were taken upstream of the diversion to Leader Lake (~ RM 11.6) on the same dates as monitoring was conducted in reach 1 (T. Neslen, OCD unpublished data [Okanogan TAG]).

Dissolved oxygen has not been measured at levels that would be detrimental to salmonid populations, ranging from 9.28 to 13.49 mg/l (T. Neslen TAG, OCD unpublished data). Based upon grab samples, water temperatures in Loup Loup Creek are conducive to salmonids. Water temperatures ranged from 32.5^{o} F to 54.0^{o} F (T. Neslen TAG, personal communication). Turbidity samples were very low, ranging from 0.4 to 2.3 NTUs. Suspended sediment measured 8 times from June 7, 2000 to May 16, 2001, ranged from 20 to 119 ppm. These low levels of turbidity and total dissolved solids suggest that erosion is not excessive in the upper watershed. However, habitat surveys in Loup Loup tributaries suggest that fine sediment delivery into the streambed is greater than that which can be flushed out of the system, based on the amount of fin sediments deposited in the streambed (see channel condition summary).

The pH in upper Loup Loup creek is closer to neutral than the moderately alkaline conditions measured downstream. The pH measured (when flows were present) from 5/17/00 to 1/17/01, ranged from 7.56 to 8.2, and averaged 7.99. These data support a good rating for this indicator.

In-Channel Habitat

Reach 1

Information regarding in-channel habitat in Loup Loup Creek is limited to reconnaissance-level surveys conducted by this author. This lower reach of Loup Loup Creek lies amongst orchards and the rural community of Malott, Washington. Where adjacent to orchards, the stream is largely channelized. Streambanks are typically grass covered and no actively eroding banks were observed. Fine sediment is less than expected possibly due to altered hydrology (i.e., flow discontinued or reduced throughout most of the year). During surveys, no large wood was observed in the lower reach. Due to development and bordering orchards, large wood is likely in lower amounts than was historically. Although not measured, pool frequency is expected to be substantially less than historical conditions due to channelization and the lack of pool forming material (i.e. large woody debris). Further data collection is required, however, reconnaissance level observations support poor ratings for both LWD and pool area, and a fair rating for fine sediments.

Reach 2

Environmental education workshops have been conducted on Rock Creek, a tributary of Loup Loup Creek, since 1997. Pebble counts on Rock Creek have indicated that fine sediment was found in frequencies greater than 50%. Possible sources of sediment could be roads into area lakes (Rock, Buzzard), logging roads and private drives. Also, there are areas that indicate concentrated cattle use along the stream and tributaries. It is not known if large wood debris surveys have been conducted along Loup Loup Creek or connected tributaries. It is suspected that large wood recruitment is lacking along certain reaches because of rural and recreational development. The amount of pool habitat in Loup Loup Creek is unknown. Based upon extremely limited information collected along Rock Creek, pool habitat in that tributary appears adequate. However, since no observations specific to the mainstem channel of Loup Loup Creek channel conditions have been recorded to our knowledge. Flow withdrawals from upper Loup Loup have likely had profound effects on riparian integrity in Loup Loup Creek which, in turn, would effect wood loading, pool area and fine sediment recruitment and distribution. Until further data collection or modeling or conducted, ranking these indicators as data gaps is prudent.

Habitat Access

Reach 1

Currently, three barriers to anadromous fish passage exist on the mainstem of Loup Loup Creek. The lowermost two barriers are culverts and the uppermost barrier (~ RM 2.5) is a set of falls. The first culvert is located within the city limits of Malott, Washington and is approximately 1/8th mile upstream from the confluence. This culvert is perched approximately 30" above the water surface and would impede adult steelhead from accessing habitat upstream. The second culvert is located approximately ¼ mile upstream from the confluence. This culvert routes Loup Loup Creek under Old Highway 97. This culvert is approximately 100 feet in length and has an estimated gradient of 1 to 2%, and is likely limits passage by adult steelhead due to increased velocities. Finally, a pair of falls, approximately each 12 feet high, exist at ~ RM 2.5. These falls are the historical extent of anadromous fish in Loup Loup Creek. These artificial passage barriers justify a ranking of poor for this habitat indicator.

Reach 2

From approximately RM 2.5 (natural falls) to the headwaters there are no known barriers to fish passage. However, there are no known surveys conducted to assess fish passage upstream of RM 2.5. Thus, fish passage in reach 2 has been ranked as a data gap.

Stream Flow

Reach 1

Resembles Natural Hydrograph—The natural hydrology in Loup Loup Creek has been severely altered since the early 1900's. Flows are reduced in lower Loup Loup Creek from a diversion located in upper Loup Loup at approximately RM 11.6. This diversion routes approximately 3,472 acre-feet of water from Loup Loup Creek to Leader Lake from October 1st to May 1st each year. This water is used for irrigation during the following year. The water right connected to this diversion has been in existence since 1913 (Water Claim Right No. 33138). In addition another diversion exists at ~ RM 2.0, and is also for the purpose of irrigation. Typically flows are non-existent downstream of RM 2.0 by mid-July. Currently, the altered hydrology of Loup Loup Creek impedes access by adult steelhead and without the reestablishment of flows this system offers no effective advantage to perpetuate or enhancing the species in the Okanogan watershed.

Impervious Surface—Estimates of impervious surface area rate the reach as 'good' (Table 5.2).

Reach 2

Resembles Natural Hydrograph—Approximately 3,500 acre-feet of Loup Loup Creek is annually diverted into Leader Lake, a storage reservoir used for irrigation. This water is diverted to Leader Lake at approximately RM 11.6, from October 1st to May 1st during the calendar year. Typically, due to water withdrawals, the lower reach of Loup Loup Creek is dry by mid-summer, and baseflows in the upper reach are also reduced. As for reach 1, withdrawals limit the ability for this creek to support anadromous or resident salmonids throughout the year. Reduced wintertime flows may limit juvenile salmonid survival by reducing habitat increasing the likelihood of anchor ice to form.

Impervious Surface—Road densities may have an effect on changes in peak run off and base flows. However, estimates of impervious surface area conducted for this LFA rate the reach as 'good' for this indicator (Table 5.2). Road densities, as of 1997, within WDNR managed lands in the basin were 1.9 miles/sq. mile and 2.7 miles/sq. mile on privately-owned lands (C. Dibble, WDNR, personal communication). Higher road density on a limited amount of private land, suggests there is a higher percentage of impervious surface in this area (southeast) of the watershed. Further data collection are required to confirm this speculation, so the rating of good for this indicator is justified for the present.

Channel Condition

Reach 1

Riparian vegetation along the lower 2.5 miles of Loup Loup Creek is altered and fragmented. Canopy closure is reduced, because riparian vegetation was noticeably removed where orchards are adjacent to the stream channel. Because of discontinuous flows, the current riparian vegetation is compromised in quantity and quality when compared to historical conditions, but still provides fair functionality.

Bank stability has not been evaluated in Loup Loup Creek. However, based upon reconnaissance-level surveys actively eroding banks were not observed along Loup Loup Creek. Grasses cover much of the streambanks and interrupted flows eliminate much of the erosive nature from spring run-off events.

Floodplain connectivity is limited in the lower 2.5.miles of Loup Loup Creek. Due to the apparent channelization of the lower reach of Loup Loup Creek the floodplain connectivity is absent. However, based upon the nearby landform it appears that Loup Loup Creek was naturally a relatively high-gradient stream. Therefore, although the floodplain connectivity is currently non-existent, it is likely that because of the high gradient the floodplain was never extensive.

Reach 2

Like the lower reach, there are sections within the upper reach that are visually absent of riparian vegetation. Exploratory surveys point towards rural development and concentrated livestock use as the cause of reduced canopy closure. As in the lower reach, Loup Loup Creek is a high gradient stream with little floodplain development. Some minimal reduction in floodplain connectivity exists, primarily from loss of riparian vegetation. The incision or bedload movement is reduced due to attenuated peak flows by water being diverted for irrigation.

Duley Lake/Joseph Flats Watershed Description

Sub-watershed Overview

The Duley Lakes/Joseph Flats sub-watershed covers 51,000 acres, and is located in the southwest plateau of the Colville Indian Reservation, in the southeastern corner of the Okanogan River watershed (Figure B-4). This area covers about 51,000 acres. Pothole lakes and ponds make up over 1300 acres of open water and there are no surface water connections to the Okanogan River from this sub-watershed.

Land Use and Ownership

Most of the basin is low-elevation mixed rangeland and shrub rangeland. Livestock grazing occurs on 90% of the land in the basin. About 6% of the land area is in non-irrigated small grain production. There are less than 300 acres of forest in the basin, and some timber harvest occurs. There is no rural development in the basin. Dirt roads parallel many of the lakes and ponds (OWC 2000).

Topography, Geology and Soils

The entire portion of the Duley Lakes/Joseph Flats sub-watershed rests atop the southwestern plateau of the Colville Indian Reservation, in the southeastern edge of the Okanogan watershed. Atop the plateau, there is minimal variation in topography relative to many of the other Okanogan sub-watersheds, with elevations ranging from about 2,000 ft to 2,600 ft. Much of the sub-watershed is composed of tertiary volcanic rocks, which range from a dark-gray to a reddish-brown basalt. Pockets of quaternary alluvium and terrace deposits left over from glacial activity can also be found in this sub-watershed. Soils are generally alkaline, rocky, and limited to grazing.

Vegetation and Riparian Condition

Vegetation is similar to the shrub-steppe and mixed rangeland found in Dan Canyon, although there is a slight increase in conifers, owing to the generally higher elevations found there. Cattle have access to the banks of the lakes, resulting in siltation and sedimentation, nutrient loading, and loss of riparian habitat. Formal studies of the degree of riparian damage were not identified in the review for this LFA.

Water Quantity/Hydrology

The potholes that dot the landscape in this sub-watershed are fed by intermittent streams and groundwater, and hold water seasonally or year round. They are more abundant in this sub-watershed than found in the adjacent Dan Canyon or Felix Creek sub-watersheds. No surface flows from the sub-watershed convey waters to the Okanogan River. Based upon map-wheel projections.

Water Quality

Waters in the sub-watershed are known to be highly alkaline (CCT 1997). The high alkalinity of the lakes in the sub-watershed likely limits their productivity, along with extreme summer and winter temperatures, nutrient loading, and lack of flushing most of the lakes have no outlet, so no flushing can occur (CCT 1997). For example, Duley Lake is eutrophic, probably due to both natural causes and nutrient loading (OWC 2000). The Colville Tribe used the Unified Watershed Assessment Categories (UWAC), a part of the EPA Clean Water Action Plan Criteria (EPA 1998), to characterize the condition of the watersheds on the reservation. Duley Lake received a Category I rating, indicating that the watershed does not meet clean water and other natural resource goals, and needs restoration.

Fisheries Resources in the Duley Lake Sub-watershed

There are no anadromous species in the streams of the plateau (**Figure B-4**). Resident fish presence in this sub-watershed is minimal as most lakes are highly alkaline or saline. Carp are likely the only fish species in Duley Lake. Rainbow trout and largemouth bass have been planted in the past, but are no longer present. The lake is alkaline and does not support most species of fish. This is true of most of the lakes in the area. Little Goose Lake, north of Duley Lake, is relatively deep, and does support a population of stocked rainbow trout (J. Marco, personal communication, 2001).

Habitat Limiting Factors Assessment in the Duley Lake/Joseph Flats Sub-watershed

No limiting factors assessment was done for Duley Lake/Joseph Flats sub-watershed because there is no anadromous fish use, and the basin is self-contained. The sub-watershed's water quality is heavily impacted by livestock grazing. The Duley Lake sub-watershed's numerous pothole lakes may affect overall basin hydrology by providing a source of groundwater to perennial and/or ephemeral streams outside of the sub-watershed's boundaries.

Felix Creek Watershed Description

Sub-watershed Overview

The Felix Creek sub-watershed comprises a variety of intermittent tributaries to the Okanogan River that drain the southwestern plateau of the Colville Indian Reservation on the eastern side of the Okanogan River. The sub-watershed is adjacent and north of the Dan Canyon sub-watershed (**Figure B-5**). Felix Creek, a second-order stream for which the sub-watershed has been named, is the largest of the Okanogan tributaries within the sub-watershed and no others have been named. Felix Creek enters the Okanogan River along the eastern side at approximately RM 24.

Surface flows from Felix Creek rarely reach the Okanogan River. The mainstem of Felix Creek is 2.9 miles long, and, based on USGS map-wheel projects, there are approximately 6 miles of stream channel in Felix Creek when its tributaries are included. Within the sub-watershed as a whole, a total of 56 miles of stream channel have been identified from the USGS, although most of these channels are generally dry or ephemeral.

The Felix Creek sub-watershed area is 3,405 acres, and elevation ranges from 820 feet at the mouth, to approximately 3,120 feet at the edge of the plateau from which surface waters could convey to the creek. (CCT 2001). A series of potholes dot the landscape in the Felix Creek sub-watershed, the largest of which is Soap Lake. The potholes in the basin are fed by intermittent streams and groundwater, and hold water seasonally or year round. Fish presence in this area is presumed minimal to non-existent, as most streams are intermittent, and most lakes are highly alkaline or saline.

Land Use and Ownership

Land cover includes deciduous forest along the Okanogan River, crop, pasture and range lands at low to mid elevations, and mixed forests at upper elevations. Agriculture is the dominant land use in the watershed. Crop production and pastureland dominate the lower part of the watershed. The mid to high elevations are used for livestock grazing, and limited timber harvest occurs in the forested area at the upper elevations as well (OWC 2000). All lands within the Felix Creek sub-watershed lie within the Colville Indian Reservation.

Topography, Geology and Soils

The southwestern plateau portion of the of the Colville Reservation that includes the Felix Creek sub-watershed is mostly mid-elevation rangeland located in the southern portion of the Okanogan watershed. The geology is dominated by undifferentiated igneous and metamorphic rocks (USGS 1954). The plateau is composed chiefly of range soils formed in basaltic glacial till and material weathered from basalt, with a mantle or component of loess. Most soils in the northwest part of the plateau escarpment derive from glacial till, weathered granite, and loess. Soils formed in glacial outwash and eolian sand with a component of loess occur at lower elevations on terraces, terrace escarpments, and dunes, along the Columbia and Okanogan Rivers. Most of the area was glaciated over a layer of basalt, which probably accounts for the many isolated lakes (CCT 1997).

Fluvial Geomorphology & In-Channel Habitat

No quantitative or qualitative studies have been conducted on the drainages in the Felix Creek sub-watershed that characterized stream channel geomorphology or in-channel habitat.

Vegetation and Riparian Conditions

No quantitative or qualitative studies were reviewed for this LFA that characterized vegetation communities or riparian conditions in the Felix Creek sub-watershed. Sagebrush-steppe probably dominated the area historically. Riparian areas were historically dominated by deciduous vegetation, with a very minor conifer component at upper elevations. Presently, the area is heavily grazed (CCT 2001).

Water Quantity/Hydrology

Felix Creek is an intermittent tributary that does not flow into the Okanogan River for most of the year. Stream flow measurements taken from March through September, 1998, were less than 1 cfs throughout the season (CCT 2000). The hydrology of the basin has been altered by timber harvest and livestock grazing practices, and by road construction, and the historic flow regime is not known. There are no water rights on Felix Creek, but there is one instance of illegal withdrawal currently under investigation. In the past, all flow was diverted from the channel for agricultural use (Trevino, personal communication, 2001).

Water Quality

Felix Creek has water quality impairments due to agricultural and grazing practices (CCT 2001). The Colville Tribe used the Unified Watershed Assessment Categories (UWAC), a part of the EPA Clean Water Action Plan Criteria (EPA 1998) to characterize the condition of the watersheds on the reservation. Felix Canyon received a Category I rating, indicating that the watershed does not meet clean water and other natural resource goals, and needs restoration. This rating was based on general knowledge of the area, and should be field checked (CCT 2001). Grazing pressures likely contribute fecal coliform and nutrients into the tributaries of the sub-watershed.

Fisheries Resources in the Felix Creek Sub-watershed

No anadromous species are known to utilize any of the streams in the Felix Creek sub-watershed (**Figure B-6**). However, presence/absence has not been recently confirmed in formal studies, and there is no historical information on fish presence (CCT, 2001). Access would appear to be prevented by naturally inadequate flows under most conditions.

Productivity in the lakes of the Felix Creek subbasin are limited presently and historically by the alkaline condition, high water temperatures, and the fact that most of the lakes have no outlet, preventing flushing from occurring (OWC 2000).

Habitat Limiting Factors Assessment in the Felix Creek Sub-watershed

This limiting factors assessment is based on observations by tribal personnel and water quality data collected since 1995 by the Colville Tribe at approximately river mile 1.5 (CCT 2001) (**Table 5-6**). Felix Creek has minimal impact on the Okanogan River because the stream rarely flows to the river during most of the year. Thus, only one reach was evaluated, the lowermost 1.5 miles.

Table 5-6: Felix Creek Limiting Factors Assessment

Habitat Pathway and Indicator*	Habitat Limiting Factor Ranking (RM 0-1.3)
Water Quality	
Dissolved Oxygen	F1
Stream Temperature	F1
Turbidity/Suspended Sediment	G1/F2
pH	DG
Nutrient Loading	DG
In Channel Habitat	
Fine Sediment (substrate)	DG
Large Woody Debris	DG
Percent Pool	DG
Habitat Access	
Fish Passage	P2
Stream Flow	
Resembles Natural Hydrograph	P2
Impervious Surface	DG
Stream Corridor	
Riparian Vegetation	DG
Stream Bank Stability	DG
Floodplain Connectivity	DG

Support for Limiting Habitat Factor Rankings in the Felix Creek Sub-watershed

Water Quality

Dissolved Oxygen—Three dissolved oxygen (DO) values were collected by the CCT in 1998 monitoring. Dissolved oxygen recorded in March, May, and August of 1998 measured 11.6. 10.4 and 7.8 mg/L, respectively. These data suggest that saturation during the summer months may be slightly below saturation. Felix Creek was given a 'fair' rating for DO, although further monitoring could support an upgrade of this ranking.

Temperature—Stream temperatures ranged from 4.5 to 20.9 degrees C. Summer water temperatures were generally over 15 degrees, and the stream was given a rating of 'fair'.

Turbidity—Turbidity levels ranged from 1 to 77 NTUs, and were generally below 10 NTUs. On this basis, turbidity in Felix Creek was rated as 'good'. Specific information on suspended sediment loads was not available.

pH—No data were available from which to rate pH, although alkaline conditions are expected, consistent with water quality through much of the Okanogan watershed.

Nutrient Loading/Chemical Contamination—There is a data gap in regards to nutrient loading. Agriculture and range activity in the basin probably contributes nutrients to the stream. Felix Creek is not on the Washington State 303(d) list (Hunner, CCT, Personal Communication to C. Fisher [Okanogan TAG] 2001).

In-Channel Habitat

There are no data on fine sediment, large woody debris, or percent pool area from the streams in the sub-watershed, thus, these habitat indicators were listed as 'data gaps' (DG).

Habitat Access

The existing habitat is limited by dewatering in the lower end of the stream during summer months as previously described. Fish passage was therefore rated as 'poor'.

Streamflow

Stream flows measured 0.54 to .70 cfs in monitoring conducted by the CCT from (Hunner, personal communication to C. Fisher, CCT [Okanogan TAG]). The natural hydrograph is assumed to have been affected by water withdrawal as well as land use practices. Felix Creek was therefore rated as 'poor' for this habitat indicator.

There are roads adjacent to stream channels in the Felix Creek drainage, but there are no quantitative data available. Extrapolations from map-wheel projections suggest the road network occupies 6.5% of the watershed area (Table 5.2), and therefore the impervious surface area rating was listed as 'fair'.

Stream Corridor

There is a data gap in regards to the habitat indicators of stream corridor condition evaluated in this LFA for this sub-watershed.

Omak Creek Watershed Description

Sub-watershed Overview

Omak Creek is a fourth order tributary of the Okanogan River that flows into the mainstem at RM 31. Of the 90,683 acres in this watershed, 73,029 acres are owned and managed by the Colville Confederated Tribes (CCT) (NRCS 1995). The climate of the sub-watershed varies from arid to mountain, with an average annual precipitation of 12 inches in the lower elevations to over 45 inches at Moses Mountain. Average daily temperatures range from 23^{o} F in winter to 70^{o} F in the summer. The average growing-season in the watershed lasts 120 days.

Approximately 8,112 (~9%) of the 90,683 acres within the Omak Creek watershed were burned or affected by the St. Mary's fire complex during August of 2001. The misapplication of fire-retardant chemicals inadvertently applied to Omak Creek and its riparian habitat resulted in a total fish kill from RM 8.4 to RM 2.9. A partial fish kill continued to nearly the confluence of the creek with the Okanogan River (RM 2.9 to RM 1.2). Over this length of creek, an estimated 10,400 fish were killed, principally resident rainbow trout, sculpin, and brook trout (Fisher and Fisher 2001). It is presumed that all offspring from the steelhead that successfully spawned in the creek in the spring of 2001 were also killed from the retardant. Trout densities recorded upstream of the spill zone yet within the burn zone (1.12/m) were higher than the highest density of trout recorded in surveys of 25 arid-mountain streams of Owyhee county Oregon (1.05/m) (Allen et al. 1998). These data indicated the loss of trout within and downstream of the retardant spill zone were attributed to the retardant and not other fire-related effects.

Land Use and Ownership

The Omak Creek watershed has 63,565 acres of commercial forest managed by the CCT (NRCS 1995). Past logging practices and fire suppression have changed the forest species composition, structure and density. These practices have led to over-stocked forest stands throughout the watershed that are susceptible to disease, insects and fire. Current logging practices include prescribed burning, pre-commercial thinning, and harvest of disease-stricken trees. Livestock producers utilize most of the forest and range areas in the watershed. Sixty percent of the rangeland in the watershed currently supports a heavy concentration of livestock, and excessive grazing along riparian areas has significantly degraded riparian conditions in some areas. Fifteen percent of the rangeland is in fair condition and only 25 percent is in either good or excellent condition (NRCS 1995). Water distribution in the uplands is inadequate to meet most agricultural and rangeland needs (NRCS 1995).

Topography, Geology and Soils

Omak creek drains lands from the east of the Okanogan river, descending from its headwaters at approximately 4,000 ft to its confluence with the Okanogan river at elevation 860 ft.. The highest peaks within the sub-watershed area drain into tributaries of Omak Creek and include Moses Mountain at the northeastern edge of the sub-watershed (6,753 ft.) and Omak Mt to the north (5,729 ft.). The riverbed and riparian areas are composed principally of quaternary alluvium and terrace deposits (Walters 1974), with adjacent hill slopes and drainage areas composed of undifferentiated igneous and metamorphic rocks. Soils are primarily derived from glacial till and material weathered from granitic rock. The soils have a mantle or component of volcanic ash or loess. Terrace soils developed in glacial outwash, eolian sand, and glacial lake sediments Soils in the watershed have a moderately low erosion potential (CCT 2001).

Fluvial Geomorphology & In-Channel Habitat

Physical habitat conditions within the Omak Creek watershed are being addressed recently through restoration practices implemented by the Colville Confederated Tribes and Natural Resource Conservation Service. Improvements have included a reduction in road density, removing two fish passage barriers, installing instream structures, planting riparian vegetation and implementing livestock management practices.

Vegetation and Riparian Condition

Riparian area vegetation in the watershed is estimated to be 54% deciduous and 46% coniferous. Riparian vegetation along the lower 5.1 miles of Omak Creek is fragmented. Lack of spring developments and inadequate fencing allows livestock access to stream corridors. This results in severe over-use of riparian vegetation and streambank failure (NRCS 1995). Reconnaissance-level and quantitative surveys have been conducted within the lower reaches of Omak Creek, identifying several lengths of eroding stream bank. Often the cause of the eroding banks was loss of riparian vegetation due to over-grazing by livestock.

Water Quantity/Hydrology

According to MWG et al. (1995) there are only 4 surface water permits on Omak Creek, amounting to a total potential withdrawal of 1 cfs or 243 acre-ft/yr. There are an additional 18 surface water claims, which could yield a withdrawal of 1.8 cfs or 332 acre-ft/yr. In addition to these surface water uses, there are 7 groundwater claims, which could account for a withdrawal of 135 gpm (0.3 cfs) or 48 acre-ft/yr. There is only 1 currently permitted groundwater withdrawal from the sub-watershed for 5 gpm.

A crest gauge maintained on a tributary to Omak Creek at Disautel (Omak Creek RM recorded annual peak flows of 1 to 13 cfs between 1956 and 1965 (Walters 1974). In an analysis of streamflows in sub-watersheds of the Colville Indian Reservation, Osborne (2000) estimated the

2 yr, 50 yr and 100 yr daily flows of 367, 897, and 1020 cfs. In that same study, the peak discharge for those flow intervals were estimated at 403, 1080, and 1200 cfs. Based upon channel measurements, (W. Trihey, ENTRIX, Inc.[Okanogan TAG]) bankfull flows in Omak Creek were estimated at 225 cfs, and the 25 yr flood flow was estimated at 790 cfs. Relative to historic conditions, flooding beyond bankfull widths has increased in recent years in the Omak Creek sub-watershed.

An extensive road transportation system exists throughout the sub-watershed as identified in WSDOT and county records (Table 5.2). Roads have been identified as a significant source of sediment (NRCS 1995) and are likely contribute to the streams "flashy" discharge via the impervious surfaces they have created. It has been estimated that there are more than 900 miles of roads within the watershed, although only approximately 265 miles of these roads in the sub-watershed are paved (Table 5-2). The Omak Creek sub-watershed inherent sensitivity has been ranked as low, and the current sensitivity rating is moderate (CCT 1996); these ratings reflect surface erosion potential. The current increase in sensitivity is considered the result of adverse road-related impacts (CCT 1996).

Water Quality

Water quality has been regularly evaluated by CCT-Environmental Trust in Omak Creek for several years (W. Hunter, personal communication, 2001). This monitoring has indicated dissolved oxygen levels appropriate for salmonid species (see Table 4.1).

Recorded temperatures can be stressful in the lower Omak Creek basin during the warmer months, exceeding both values suitable for optimal growth (Fisher 2000) and even survival (Brett 1952). All locations examined in Omak Creek and its tributaries received habitat quality index ratings of moderate to poor for temperature in previous studies (CCT 1996). Temperature information continues to be collected and tribal restoration efforts are directed towards reaches that contribute to warm water conditions.

Accelerated sediment yields from uplands and streambanks was identified as one of the main factors affecting water quality in Omak Creek (NRCS 1995).

Fisheries Resources in Omak Creek

The Omak Creek watershed supports a variety of fish species, including resident rainbow and brook trout, and the federally endangered anadromous steelhead trout. Other species (e.g., Cottis sp., Prosopium williamsoni) also inhabit the creek, particularly in its lower reaches. In an effort to reestablish a locally adapted steelhead stock the CCT Fish and Wildlife Department, in a coordinated effort with Washington Department of Fish and Wildlife, has been stocking steelhead smolts in Omak Creek since 1980. The CCT has also recently embarked upon the re-introduction of spring chinook salmon into the creek, and some 100,000 fry and 40,000 smolts were released into the upper watershed in the spring of 2001. (The National Marine Fisheries Service has considered spring chinook to be extinct in the upper Columbia for many years). Historically, Omak Creek supported steelhead and chinook salmon which were culturally important to the members of the Colville Confederated Tribes. It is presumed that steelhead utilized most of the perennial stream channels within the watershed, although Mission Falls (RM 8) was likely an effective barrier to Chinook salmon.

For this analysis two reaches were evaluated in Omak Creek (**Table 5-7**). The lower reach extends from the confluence to the base of Mission Falls (~ RM 5.1). Mission Falls was likely the extent of the historical range of Chinook salmon in Omak Creek. The upper reach extends from Mission Falls to the upper end of Omak Creek. The source of habitat and water quality information provided for this analysis of Omak Creek and associated tributaries was from surveys conducted by the Colville Confederated Tribes Fish and Wildlife staff or Environmental Trust and the Natural Resources Conservation Service.

Table 5-7: Omak Creek Limiting Factors Assessment

Habitat Pathway and Indicator*	0.0 to 5.1 Reach1	5.1 to 25.0 Reach 2
Water Quality		
Dissolved Oxygen	F2	G2
Stream Temperature	P1	F1
Turbidity/Suspended Sediment	P1	P1
pH	F2	F1
Nutrient Loading	F1	F1
In Channel Habitat		
Fine Sediment (substrate)	P1	F2
Large Woody Debris	F1	F1
Percent Pool	G1	F1
Habitat Access		
Fish Passage	G1	F1
Streamflow		
Resembles Natural Hydrograph	P2	P2
Impervious Surface	F2	F2
Stream Corridor		
Riparian Vegetation	P1	F2
Streambank Stability	P1	F2
Floodplain Connectivity	P2	F2

*Pathway in bold, indicator in plain type

Additional Support for Limiting Factors Assessment Ratings in the Omak Creek Sub-watershed

Water Quality

Reach 1

Dissolved oxygen has not been identified as problematic in the lower reach, but was rated as 'fair' because of high nutrient loading in this reach that likely reduces saturation through elevated biological oxygen demand (BOD).

Water temperature has exceeded lethal levels for steelhead (75^{o} F; Bell 1986) and is marginal for chinook salmon (79^{o} F; Brett 1952) in the lower reaches of Omak Creek in the summer months (78^{o} F, 1997; 79.9^{o} F, 1998; 78^{o} F, 1999; 75.5^{o} F, 2000, CCT, unpublished data). For this reason, temperature was listed as 'poor' in reach 1.

Turbidity was evaluated twice during an 8-day period in 1990. NTUs's varied from 24.0 to 39.0 NTUs. Most of the year (10 months) value is less than 20 NTUs, but some samples (13) have exceeded 100 NTUs and several have been between 20 and 100 NTUs but only during the months of April and May (W. Hunter, CCT – Environmental Trust, unpublished data). It is suspected that the major source of turbidity originates in the watershed from upstream of Mission Falls. Total suspended solids have exceeded 130 mg/l during April and May, corresponding with peak spawning times for steelhead (W. Hunter, CCT – Environmental Trust, unpublished data).

No data were reviewed from which to rate pH values in reach 1; however, measurements upstream of reach 1 have exceeded 8.5, and it is not expected that conditions would likely differ in the upper portion of the stream with respect to alkaline contributions and conditions. For this reason, pH was rated as fair in reach 2.

Besides thermal and turbidity impairments, fecal coliform was detected in high concentrations and found to be the cause of water quality standard non-compliance (NRCS 1995). Fecal coliform, nutrients (nitrate, phosphate) and ammonia have been recorded in lower and upper reaches of Omak Creek, primarily from livestock and also septic tanks (W. Hunter, CCT – Environmental Trust, unpublished data). In August of 2001 reach 1 of Omak Creek also received an excessive “dose” of fire retardant accidentally applied to the creek during fire suppression activities in reach 2. The active ingredient of the retardant, ammonium polyphosphate, resulted in a complete fish kill for the majority of waters captured by reach 1, and the lower portion of reach 2. The impacts of this spill have been described in detail elsewhere (Fisher and Fisher 2001), but it is noted here that a significant amount of retardant landed within the riparian corridor and atop stream bed sediments outside the wetted perimeter, but within the bankfull width of the stream. Although the retardant that landed in the creek was diluted rapidly due its soluble chemical formulation, the residual contamination of the riparian zone and shoreline habitats will likely serve as a source of recontamination, and thereby increase the nutrient enrichment for some time. For this reason, the nutrients/contaminants habitat indicator was rated as ‘fair’, recognizing that the system is at risk from elevated nutrients, and that a more complete data set is needed to establish potential effects on habitat function for salmonids.

Reach 2

Dissolved oxygen - has not been measured by the CCT at levels that would be detrimental to salmonid performance (See reach 1). For this reason, it was rated as good.

Water temperature - data has been collected at four locations (Disautel, Haley Creek confluence, Stapaloop Creek, Trail Creek) within this reach since 1999. Water temperatures exceeding 70^{o} F during the 2-year time period were recorded in Stapaloop Creek during 1999 and at the Haley Creek confluence during both years. For this reason, reach 2 was rated fair for temperature.

Turbidity - samples were collected on May 14, 1990 ranged from 18 (Hwy 155 bridge near Trail Creek) to 42 (Disautel). On May 23, 1990 turbidity samples ranged from 4 NTUs in Stapaloop Creek to 21 NTUs at Haley Creek. During April 23, 1990 turbidity was sampled and ranged from 50 NTUs at Hwy 155 to 29 NTUs at Haley Creek (See reach 1). Sampling the volume of sediment in pools (V*) was conducted during August 2000. Although the collected data has not been analyzed, depths within an upstream reach often exceeded 2 feet, indicating a high amount sediment delivered to Omak Creek. These data support a rating of poor for this indicator. Based upon an observation of approximately 6” of sediment deposited there is evidence that suspended sediment may, at times, exceed levels appropriate for salmonid health and habitat.

pH was measured in excess of 8.5 during field investigations of the retardant-induced fish kill in Omak Creek during August 2001. For this reason, the pH was rated as “fair”. Other monitoring by the CCT prior to the spill has also measured pH values in excess of 8.5. Values in excess of 9.0 have not been recorded to our knowledge.

In-Channel Habitat

Reach 1

A fish spawning substrate evaluation was conducted by CCT - Fish and Wildlife staff during 1989. The results of this study found fine sediment tightly packed around the larger materials and it was causing a cementing effect in the downstream reaches. Percent fines averaged 14.2% across two sample sites in this reach. This percentage appears relatively low, however, sampling occurred in riffles, or areas of fast flowing water. Thus areas of lower stream velocities and preferred spawning sites by salmonids (pool tail-out) are likely to have greater amount of fine sediment.

A Timber Fish and Wildlife (TFW) Ambient Monitoring Stream Survey was conducted by CCT-Fish and Wildlife Department personnel during 1992. The survey was divided into 5 segments (based on valley form) and conducted over 12.2 miles of Omak Creek. For the habitat survey large wood was counted if it exceeded 2 meters in length and a diameter of at least 10 cm. The frequency of large woody debris was not recorded within the lower 3 reaches (RM 0.0 to 5.1). However, it is suspected that there is a deficiency in the frequency of large wood when compared to historical conditions. During the 1920's a railroad was routed along Omak Creek and is a likely cause of the current deficiency of large woody debris. Beaver dams were also identified as one of the main factors contributing to pool formation, which may also be a cause to the deficiency in LWD in Omak Creek. However, LWD, as defined by these criteria, may not be as critical a factor in Omak Creek. Channel bedform created as much as 38% of the pools in one segment. Rootwads and roots of standing trees also contributed to creating pools. However, Omak Creek is considered to have sufficient amount of large wood and is properly functioning (i.e., 'good') for this parameter but may be deficient compared to what may have been present historically. Because of the reduced recruitment potential, the large wood loading conditions were rated as fair.

Percent pool habitat was measured as good (≥50% of habitat) for both segments (55.4%, 51.6%) in this reach (CCT 1992). Ruggles (1966) and Platts et al. (1983) considered a stream with 50% pools is generally considered to possess good habitat attributes. The main factors contributing to pool formation in both segments were beaver dams and channel bedform. The prevalence of beaver is likely a contributing factor to limited large woody debris in the lower reach.

Reach 2

Again as stated earlier, sediment yield models indicated overland erosion was one of the main factors affecting water quality in Omak Creek (NRCS 1995). A fish spawning substrate evaluation found fines averaged 18.3% across 6 sample sites upstream of Mission Falls (J. Hansen, CCT, 1992). This percentage appears relatively low, however, sampling occurred in riffles, or areas of fast flowing water. Thus areas of lower stream velocities and preferred spawning sites by salmonids (pool tail-out) are likely to have greater amount of fine sediment. Also, the percentage of fine sediment was determined by weight. Therefore, there was likely a large amount of fine sediment to equal 18.3% by weight. More recently, V* (V star) sampling was conducted along 2 reaches of Omak Creek upstream of Mission Falls. One reach, near the confluence of Trail Creek, revealed depths of sediment often exceeding 2 ft. (C. Fisher, CCT, unpublished data).

A likely source of sediment in this reach is from roads. Approximately 900 miles of road were recognized within the Omak Creek watershed (141.7 square miles). However, it is known that more than 900 miles of road exist in the watershed.

During 1995 a habitat survey was conducted in Trail Creek, a perennial tributary of Omak Creek with its source from Moses Mountain. Large woody debris was in abundance within the lower three reaches of Trail Creek (156, 270 and 218 pieces/mile). However this was likely an overestimate because pieces with lengths over 6 feet were recorded (CCT, unpublished data). Based upon reconnaissance level surveys it appears that woody debris occurs in Trail Creek in sufficient frequency to provide adequate habitat complexity (pool formation, fish cover, nutrient input, etc.) and bank stability. During a 1992 survey LWD was evaluated upstream of Mission Falls for 4 miles. The frequency of large wood was 16 and 31 pieces per mile for diameters > 20 cm and > 10 cm, respectively.

In two reaches (4.0 and 3.2 miles) upstream of Mission Falls pool area was estimated at 31.3% and 35.8%.

Habitat Access

Reach 1

Formerly two barriers to anadromous fish passage existed on the mainstem of Omak Creek. The lowermost barrier was created by a timber mill, which routed Omak Creek through approximately 1600 feet of corrugated metal pipe (cmp). This barrier was virtually impassable for both steelhead and Chinook salmon. Omak Creek was relocated in an open channel approximately 100 feet away from the mill site during the spring of 1999. The second barrier, at ~ RM 5.1, was created from the rubble and cribbing used in the construction of a rail system along Omak Creek during the 1920's. This railroad material was deposited into the canyon at Mission Falls and made the upstream reach inaccessible to anadromous salmonids. During the fall of 1998, approximately 28,000 cubic yards of rubble and cribbing material was removed from Mission Falls. Currently, the Mission Falls reach is being evaluated for fish passage by steelhead. Because of the gradient (approximately 12%) and reduced streamflow during June and July, it is assumed that Mission Falls was always impassable to spring Chinook salmon.

Reach 2

One barrier to fish passage is a culvert, which routes Stapaloop Creek, a perennial tributary to Omak Creek, under Highway 155. This culvert exists at approximately RM 0.5 and prevents access to about 4 miles of Stapaloop Creek. Currently, it is unknown if other artificial barriers exist which prevent anadromous fish access to habitat in upstream reaches.

Flow

Reaches 1 & 2

During 1998, peak flows, in response to mild air temperatures and spring rains, have been of short duration and have exceeded bank full discharge. This peak flow response was known to occur three times during the spring of 1998 and indicates the natural hydrograph is impaired. The pronounced changes in timing and discharge (e.g., multiple peak flows) suggest that alterations and disturbances exist which modified the hydrological characteristics in the basin from its natural hydrograph. Thus, both reaches were rated as poor, although additional data collection to support this rating are needed.

Based upon map wheel projections from USGS 1:100,000 maps, and GIS interpretations, the paved road network meets the 'good' criteria. However, because this estimate does not include non-paved roads that may bring this total to (at least) 900 miles this habitat indicator of hydrology was rated as 'fair', with the qualifier of professional judgement (i.e., '2').

Channel Condition

Reach 1

Canopy closure was evaluated at random sites downstream of Mission Falls (C. Fisher, CCT, unpublished data). The survey indicated riparian vegetation was scarce along this 2-mile reach and likely caused by poor livestock management. Along the lowermost 2-miles riparian vegetation is minimal. This reach contains approximately 0.5 miles of newly-constructed stream channel where riparian vegetation is being established and the remaining 1.5 miles is channelized with limited riparian vegetation.

Bank stability has not been evaluated in Omak Creek. However, in the Omak Creek Watershed Plan/Environmental Assessment (NRCS 1995) bank stability measures were identified. Recent observations indicate bank erosion occurring along several isolated reaches. Again, downstream of Mission Falls several areas of vertical bank cutting are actively eroding. The most common cause of this erosion appears from poor livestock management. The reduction of woody plant species and the associated root systems have also caused banks to become unstable. Within the lowermost 2 miles, severe erosion is occurring along 0.5 mile reach that was constructed during the winter of 1998. This severe erosion is due to poor lateral channel stability. Surveys along the stream have allowed for estimates of 80% of the bank vegetated and stable. Parts of the Omak Creek Watershed Plan/Environmental Assessment are being implemented and include grazing management practices, which will allow the over-utilized areas to become reestablished with woody vegetation. Professional judgment considers the current condition for bank stability to be functioning at risk.

Floodplain connectivity is limited in the lower 5.1 miles of Omak Creek. Floodplain connectivity is absent along an approximately 3-mile reach downstream of Mission Falls where severe bank erosion exists. However, where bank erosion is not evident and gradient is not high (> 2%), floodplain connectivity does exist. Restoration efforts are being directed to improve bank stability, reduce erosion and reestablish floodplain connectivity.

Reach 2

As in the lower reach, there are areas in the upper reach that are obviously absent of riparian vegetation. Canopy closure, which was 46 and 57% along two stream segments, substantiates this condition (TFW 1992).

Where vegetation is absent, bank stability is poor. Several reaches containing actively eroding banks have been observed near the community of Disautel (~ RM 16.0). Upstream of Mission Falls (RM 5.1), particularly near the community of Disautel, Omak Creek has been disconnected from the floodplain. The cause appears to be from loss of riparian vegetation and residential development that drained most of the adjacent wetlands.

Salmon Creek Watershed Description

Sub-watershed Overview

Salmon Creek is a perennial tributary of the Okanogan River with a total watershed area of about 167 square miles. It enters the Okanogan River at the town of Okanogan. Mountains surround Salmon Creek forming its hydrologic divides. The basin is generally oriented on a northwest-southeast axis, with a broad upper watershed about 8 to 10 miles wide and 12 to 15 miles long. The North Fork, West Fork, and South Fork of Salmon Creek converge at Conconully draining the 119 square-mile upper Salmon watershed. This portion of watershed is inaccessible to anadromous fish because of Conconully Dam and Reservoir. Conconully Dam is approximately

15 miles upstream from the mouth of Salmon Creek. Although data or written references are unavailable to define historic use of the upper watershed by anadromous salmonids, professional opinion is that it was probably limited to less than three miles above the damsite.

The Okanogan Irrigation District (OID) manages Conconully Reservoir to serve District lands east of the watershed. Controlled releases for irrigation deliveries are made from Conconully Reservoir between April and October. These releases are conveyed through 11 miles of natural and modified stream channel (referred to as the middle reach of Salmon Creek) to the OID diversion dam, located 4.3 stream miles above the mouth of Salmon Creek. For more than eighty years, the 4.3 miles of Salmon Creek downstream of the OID diversion dam (referred to as lower Salmon Creek), have been dewatered, except during snowmelt events that result in uncontrolled spill at the OID diversion dam.

Land Use and Ownership

Land use within this semi-arid region has been, and continues to be, tied directly to water use including: transportation, mineral exploration, irrigation, domestic use, livestock, and recreation. In 1886 mining activities began. Mining in the Salmon Creek area continued until 1983; most notably from 1937 through 1939, and from 1958 through 1964 (USFS 1997). Also, in 1886 water was diverted for irrigation. Water diversions increased until 1921 and resulted in the construction of two dams: Conconully in 1908 and Salmon Lake Dam in 1921. Extensive Livestock grazing throughout the watershed began in the late 1800s and continued through the early 1900s. Generally during this time period, cattle grazed the lower elevations while sheep were driven into the higher ranges (Bennett 1979, USFS 1997).

Present land ownership and use in the upper Salmon watershed is dominated by the USFS (80 percent), with a minor area (2 percent) managed by the Bureau of Land Management (USFS 1997). Land ownership in the middle and lower reaches is primarily private. However, some state and local lands exist in riparian areas, such as near the OID dam and Watercress Springs.

Topography, Geology & Soils

Elevations of the upper Salmon watershed range from 2,318 feet at Conconully to 8,242 feet at Tiffany Mountain (USFS 1997). The valley floor along the middle reach decreases from about 2,200 feet at Conconully dam to 1,350 feet at the OID dam. Ridge elevations along the west and east watershed divides are about 4,900 and 3,700 feet, respectively. The elevation of Salmon Creek at its confluence with the Okanogan River is about 800 feet.

Three major geologic events have played a leading role in shaping the topography and soil characteristics of the Salmon Creek watershed: granitic uplifting during the Cretaceous period, glacial activity during the Quaternary period, and post-glacial volcanic activity (USFS 1997).

The higher elevations in the upper watershed are dominated by cirque headlands and basins, which flow outward to form glacial troughs and valleys. Pleistocene glaciation and ice-margin streams carved the valleys of the upper watershed. Soils are close to bedrock and extensive rock outcrops exist. The lower sideslopes and foothills are dominated by deep glacial deposits that have been influenced and affected to some degree by mixed colluvium and alluvium deposition that followed the retreat of the glaciers about 10 to 15 thousand years ago (USFS 1997).

The Salmon Creek valley gradually widens downstream of Conconully Dam and becomes underlain by clay, sand, gravel, and boulders. Thick deposits of glacial till and outwash occur; particularly along the lower 2 miles of Salmon Creek.

Water Quantity/Hydrology

Water supply

Annual average precipitation in the upper Salmon watershed ranges from about 15 inches near Conconully to 30 inches in the mountains along the western edge of the watershed. Annual precipitation in the middle and lower portions of the watershed averages 12 to 15 inches. Near the confluence of Salmon Creek with the Okanogan River (800 ft msl), precipitation in the form of snowfall typically occurs from November to March. Trace amounts of snowfall may occur in October and April. At elevations above 1,500 feet, snowfall is two to four times greater than that occurring at lower elevations. Rainfall between May and September is low, generally less than 1.5 inches.

Annual runoff from the Salmon Creek basin is highly variable. This variability is so extreme that although all surface runoff from the upper watershed flows into Conconully Reservoir or Salmon Lake, it has often been insufficient to fill the reservoirs. Conconully reservoir has seen everything from record floods to extended dry periods. The longest dry period extended from 1917 until 1938 (Yates 1968).

Municipal water use in the vicinity of Salmon Creek is limited to the City of Okanogan, which relies principally on groundwater wells. However, the municipal water supply is supplemented by extraction from Watercress Springs located along Salmon Creek about 2 miles upstream from its mouth. Groundwater also provides domestic water for of the residents of Conconully and other valley residents. According to MWG et al. (1995) there are a total of 190 groundwater claims and 39 confirmed permits. Permitted withdrawals could account for 9,134 gpm of water (20.36 cfs). Additional groundwater claims could account for the additive withdrawal of 7,056 gpm (15.7) if exercised. There are an additional 5 applications pending for which another 845 gpm could be permitted.

Today, a substantial portion of Salmon Creek flows are diverted and/or stored (e.g., Conconully Dam). In addition, direct withdrawal for irrigation and home use is permitted within the basin. There are 89 permits for surface water withdrawals currently granted on Salmon Creek, which could yield a total 2.9 cfs (MWG et al. 1995). In addition, there are another 137 claims for a total of 408 cfs.

Streamflow

Salmon Creek contributes about 2% to the average annual streamflow of the Okanogan River at Malott (WDOE 1995). Prior to regulation by impoundment (1904-1909) the annual average discharge of Salmon Creek was recorded as being from 35 to 80 cfs, and averaged 49 cfs (35,500 acre-feet per year) (WDOE 1976). Monthly discharge ranged from about 15 cfs August through March to approximately 114 cfs April through July (Walters 1974).

It is important to note that streamflow data recorded prior to construction of Conconully Dam represent a period of record containing only average and above average water years (as compared to the full 1904-1998 period of record). For the long-term period of record (1904-1998), the average annual runoff is 21,700 acre-feet (30 cfs) or 63% less than the 1904 to 1909 average.

August through March flows range between 5 and 10 cfs rather than near the 15 cfs reported in the early 1900 record (Dames and Moore 1999).

There is a general tendency for streamflow gain between Conconully Reservoir and the OID diversion, and for streamflow loss between the OID diversion and the mouth of Salmon Creek. The loss of streamflow was first documented by Monk and Fisher (1998) then confirmed by Trihey and Mahacek (Dames and Moore 1999). The 24 percent loss measured by Monk and Fisher in April 1998 during a 19.8 cfs spill at the OID diversion dam is of a similar magnitude as the 31 percent loss measured during a 19.2 cfs release in March 1999.

It is expected that antecedent moisture conditions and weather patterns have a significant influence on streamflow losses in lower Salmon Creek. Antecedent moisture conditions affect groundwater contributions to baseflow, and are likely to vary between months and between water year types. The 1999 study was conducted in the spring following two relatively high precipitation years. The 1998 study was also conducted in the spring following a relatively high precipitation year. Therefore, the stream flow losses measured in 1998 and 1999 may be significantly less than what would be measured in late fall or during drier years. However, it is possible that returning permanent streamflow to Salmon Creek below the OID diversion dam would eventually recharge the streambed and reach losses would become less than the measured values.

Fisheries Resources in Salmon Creek

There are three races/demes of chinook salmon in the Columbia River basin: spring, summer, and fall; and two races of steelhead: summer and winter. Steelhead runs in the Columbia River upstream of the Deschutes River (including the Snake River) are exclusively summer-run fish (Peven 1990). However, there are two subgroups of summer-run steelhead that are differentiated by their time of entry into the Columbia River. The “A” group enters the river in June and July, where as the “B” group enters the river during August and September. The mid-and upper Columbia River steelhead, that could potentially enter Salmon Creek, belong to the “A” group (Chrisp and Bjornn 1978).

Anadromous Salmonids known to have historically occurred in Salmon Creek include spring chinook (*Oncorhynchus tshawytscha*) and summer steelhead (*O. mykiss*). Before the construction of Conconully Dam in 1910, these anadromous fish may have utilized the north, west and south forks of Salmon Creek for two or three miles above the dam site. Both spring chinook and summer steelhead have recently been listed as “endangered” under the Endangered Species Act. Spring chinook are thought to be extirpated from Salmon Creek. Summer steelhead are occasionally observed in the creek during high water years (**Figure B-7**).

NMFS considers all Columbia River steelhead returning to spawning areas upstream of the Yakima river confluence as belonging to the same ESU (NMFS 1997). This ESU is currently listed as “endangered,” and includes the Wenatchee, Entiat, Methow, and Okanogan watersheds. The Wells Hatchery steelhead stock is also included in this ESU because it is considered essential for the recovery of the natural population.

Habitat Limiting Factors Assessment of the Salmon Creek Sub-watershed

For purposes of this limiting factor assessment, the 15 mile (approximate) segment of Salmon Creek between Conconully Dam and the Okanogan river has been divided into three reaches (**Table 5-8**). These reaches are necessary because of significant differences in streamflow above and below the OID diversion dam that dramatically affect the character of the stream channel and the availability and quality of salmonid habitats. Past and present land use practices are also an important factor influencing stream corridor conditions and salmonid habitats but the adverse effects of these practices are small relative to the adverse influence of streamflow alterations.

Reach 1 begins at the mouth of Salmon Creek and extends upstream 1.75 miles to below Watercress Springs. Reach 2 is 2.55 miles in length and extends from the lower end of Watercress Springs to the OID Diversion Dam RM 4.3. Reach 3 extends from the OID diversion dam upstream 11 miles to Conconully Dam a distance of eleven miles.

Table 5-8. Salmon Creek Limiting Factors Assessment.

Habitat Pathway and Indicator*	**Limiting Habitat Factor Ranking by Reach**		
	Okanogan River Reach 1 Mouth to 1.75 miles	**OID Diversion Dam and Watercress Springs Reach 2 1.75-4.30 miles**	**Conconully Dam Reach 3 4.30-15.3 miles**
Water Quality			
Dissolved Oxygen	DG	DG	DG
Stream Temperature	DG	DG	P1
Turbidity/Suspended Sediment	P2	P2	P2
pH	DG	DG	DG
Nutrient Loading	DG	DG	DG
In Channel Habitat			
Fine Sediment (sedimentation)	P2	P2	P2
Large Woody Debris	P2	P2	P2
Percent Pool	P1	P1	P1
Habitat Access			
Fish Passage	P1	P1	P2
Streamflow			
Resembles Natural Hydrograph	P1	P1	P1
Impervious Surface	G2	G2	G2
Stream Corridor			
Riparian Vegetation	P1	P1	P1
Streambank Stability	P1	P1	P1
Floodplain Connectivity	P1	P1	P1

*pathway in bold, indicator in plain type

Additional Support for Limiting Factors Assessment Ratings in the Salmon Creek Sub-watershed

Reach 1

Nearly all stream corridor attributes considered in Reach 1 are poor. Most notable in Reach 1 is the absence of riparian vegetation and persistence of an incised and unstable stream channel. Both are attributable to the prolonged absence of base streamflow and the periodic occurrence of flood events (i.e. large uncontrolled spills at Conconully Dam).

When observed at moderate streamflow levels (15 to 30 cfs) this reach provided poor to fair adult passage because of excessive channel width and lack of pool habitat for resting area. However, the complexity of the boulder/cobble channel boundary and associated hydraulic conditions provided excellent potential living space for juvenile salmonids.

At moderate streamflows (15 to 30 cfs) streambanks were not eroding and water clarity was good. At high streamflows such as would occur during snowmelt runoff water clarity is expected to be fair or poor due to surface runoff above Danker Cutoff Road and streambank erosion between RM 0.75 and RM 1.75.

Reach 2

When streamflow exceeding 10 cfs is present in Reach 2, dissolved oxygen and stream temperature are probably adequate to support salmonids. However, data should be collected to verify or correct this impression. Watercress springs, at the lower end of Reach 2, should provide water of nearly uniform temperature throughout the year and hot temperature should be very close to the mean annual air temperature.

Suspended sediment concentrations or turbidity levels have not been cited in prior assessments as being of concern. Data are not available and observations have not been made by this author to support informed judgement. An initial opinion is that elevated turbidity and suspended sediment levels probably occur with snowmelt runoff events. The degree to which these events might adversely affect fish or fish habitat is unknown. Most sand sized and larger particles originating in Segment 3 are captured by the sand traps at OID's diversion dam. Thus, most coarse grained suspended sediment and fine grained bedload present in Reach 2 would have to originate in this reach. Fine grained suspended sediment, that which influences turbidity, could originate in either Reach 3 or Reach 2. Hansen (1995) and Fisher and Fedderson (1998) reported undesirably high amounts of fine sediment in spawning gravel in Reach 3.

Informal observations by this author indicate that small discontinuous patches of usable spawning gravel exist in Reach 2 but, in general, spawning habitat is limited in quantity and quality by substrate size or percent fines. Substrate is generally large and clean enough in the vicinity of Danker cutoff road and watercress springs to provide good cover for juvenile salmonids.

Large woody debris is typically absent from the channel. The absence of LWD is probably as attributable to landowner behavior as it is to poor recruitment potential.

Channel complexity is fair between the OID diversion dam and Danker cutoff. Run, riffle and pool habitats exist but habitat quality is suppressed by very low streamflow. At moderate streamflow this sub reach is dominated by good quality riffle and run habitats. From Danker cutoff to Watercress Springs channel complexity improves considerably due to substrate composition. This sub reach is dominated by large bed element, riffle run and pocket water habitats. The quality of these habitats is typically suppressed by very low streamflow. However at moderate streamflows excellent rearing habitat exists in this reach.

If streamflow exists in Reach 2 it is present because of spill at the OID diversion dam. Thus streamflow in Reach 2 can be described as seasonal, sporadic and unreliable. In wet years seepage, leakage and shallow groundwater inflow maintains a wet channel with isolated shallow pools for a mile or so below the diversion dam. Watercress springs contributes to a wet channel in that area but continuous streamflow seldom exists year round in Reach 2. As a result, fish passage and habitat conditions are typically poor throughout the reach.

Riparian vegetation in Segment 2 ranges from poor to good. Good conditions exist near Watercress Springs. Elsewhere the condition of riparian vegetation is quite poor; possibly being fair in a few small areas. Flood plain function is uniformly poor due to land use practices.

Reach 3

Neither dissolved oxygen or water temperature have been suggested as being problematic in prior studies (albeit data are very limited).

Data have not been collected on dissolved oxygen but the visual appearances of the reach do not suggest low oxygen levels are likely to be of concern (e.g., good aeration). It is possible for low level releases from Conconully Dam to have a low oxygen content but the steep channel gradient and large bed material would likely result in streamflow being oxygenated within a couple miles. The collection of seasonal dissolved oxygen profiles near the outlet from Conconully lake would indicate whether dissolved oxygen data should be collected in Salmon Creek.

Stream temperature data collected by CCT fisheries staff during 1997 and 1998 indicate that the temperature of Reach 3 did not exceed 68°F (Fisher & Fedderson 1998).

The Okanogan Watershed Water Quality Plan (OWC 2000) does not identify suspended sediment concentrations (or turbidity) as being of concern in Salmon Creek. This author's observation of the general condition of the Salmon Creek corridor in Reach 3 indicate that elevated turbidity, suspended sediment and BOD loading is likely during April and May due to snowmelt runoff from agricultural lands in the flood plain. Whether or not these inputs are high enough to be harmful to fish or their habitats in this reach is unknown. Data would need to be collected before an informed opinion will exist.

The most extensive survey of stream morphology and associated habitat conditions was conducted in 1999 by Barry Sutherland (NRCS 1999).

Construction and operation of Conconully Reservoir has altered the shape of the natural hydrograph in Reach 3 but, as described below, it is unlikely that the nature or magnitude of these alterations are detrimental to the utilization of this reach by salmonids. Both Conconully Reservoir and Conconully Lake (Salmon Lake) are operated as irrigation storage reservoirs. Decisions are made each spring by the Okanogan Irrigation District regarding reservoir operation during the snowmelt runoff season. However no formal agreement exists regarding reservoir operation for flood control. Although efforts are made to provide storage during the anticipated period of peak runoff, the reservoirs fill and spill during normal and above normal snowpack years. The timing, duration and magnitude of spill is strongly influenced by water year type. During the irrigation season (April – October) Reach 3 of Salmon Creek conveys water released from Conconully Dam for irrigation delivery. Stream flows during May and June are substantially lower than what would occur naturally; and they are notably higher during August, September and October. Streamflow conditions for Spring Chinook and Summer Steelhead migration, spawning and rearing are considered good. Winter streamflows (November – March) may be about the same or somewhat lower than natural. This is a topic area yet to be investigated.

In general, riparian vegetation and flood plain function varies from good to poor depending upon location with in the reach. The stream corridor is too inaccessible, narrow, and steep within the 4 miles below Conconully Dam to support extensive utilization of the stream corridor by man. Thus, the general condition of its riparian vegetation and floodplain function is quite good. Between the former town of Ruby and the OID diversion dam, a distance of approximately six miles, the stream corridor is extensively utilized for livestock, pasture, or hay, wheat, and barley fields. In some locations the stream appears to have been moved from its natural water course. The general condition of riparian vegetation and flood plain varies from good to poor depending upon location. The general condition of the riparian vegetation and degree of flood plain development undoubtedly has a negative effect (albeit unquantified) on streambank stability and sediment/BOD loading from overland and rill flow. The general condition of riparian vegetation in Segment 3 may have some negative influence on stream temperature, oloconous input, benthic production and cover. However, this author's observation of Reach 3 would suggest that more than half of this 11 mile stream reach has good riparian shade and potential for oloconous input.

Wanacut Creek Watershed Description

Sub-watershed Overview

Wanacut Creek is a third order intermittent tributary to the Okanogan River located on the Colville Indian Reservation immediately north of the Omak Creek sub-watershed. Wanacut Creek flows westward, entering the eastern side of the Okanogan River at approximately RM 30, (CCT 2001). The total area of the Wanacut Creek sub-watershed is 12,595 acres, representing 0.76% of the total Okanogan watershed (OWC 2000). The Wanacut Creek mainstem is approximately 7.6 miles long, with a total of approximately 38.7 miles of stream channel in the sub-watershed (Table 5.2).

Land Use and Ownership

Land use in the Wanacut drainage includes timber harvest, livestock grazing and pastureland, industry, and residential development. The lower portion of the Wanacut watershed is used for crop production and pasture. The uplands consist of rangeland and residential development. According to the OCD (2000), 44.5 % (5,599 acres) of the sub-watershed is in forest production, 52.3 % is in rangeland (6,586 acres), 3.2% (411 acres) is in crop production—primarily irrigated hay and non-irrigated pasture. At higher elevations, mixed rangeland, mixed forest, and coniferous forest dominate (CCT 2001). See **Table 5-9** for land use types percentages.

Table 5-9: Land Use/Types in the Wanacut Creek Watershed by Acreage and Percentage of Total Watershed Area (OWC, 2000)

Land Use/Land Type	Acreage	Percentage
Range	6586	52%
Forest	5598	49%
Irrigated hay	317.7	2.5%
Non-irrigated pasture, hay or feedlots	92.8	0.7%

Topography, Geology and Soils

Elevations within the sub-watershed range from 860 feet at the Okanogan River confluence, to 5749 feet, the summit of Omak Mountain. On the basis of USGS 1:100,000 scale mapping, the main channel headwaters of the sub-watershed begin at an elevation of approximately 4,250 ft., yielding an average elevation drop in Wanacut Creek is 446 feet/mile. The average drainage gradient is thus approximately 8.5%.

Geology in the Wanacut Creek sub-watershed is composed primarily of undifferentiated igneous and metamorphic rocks of various ages that do not generally bear water (USGS 1954). Soils are primarily derived from glacial till and material weathered from granitic rock. The soils have a mantle or component of volcanic ash or loess. Terrace soils developed in glacial outwash, eolian sand, and glacial lake sediments Soils in the watershed have a moderately low erosion potential (CCT 2001).

Fluvial Geomorphology & In-Channel Habitat

No formal studies were reviewed that quantified or otherwise characterized fluvial geomorphology or in-channel habitat conditions in the Wanacut Creek sub-watershed.

Vegetation and Riparian Condition

No formal studies were reviewed that quantified or otherwise characterized riparian condition in the Chiliwist sub-watershed. Vegetation communities within the Wanacut sub-watershed are presumed similar to those found within the adjacent Omak Creek sub-watershed.

Water Quantity/Hydrology

Wanacut Creek is an intermittent stream, but may have flowed year round historically. Average annual precipitation in the sub-watershed is 16 inches. The hydrology in the basin has been altered by timber harvest, road construction, livestock grazing, and other land use practices in the uplands and riparian corridor, but unlike many of the other sub-watersheds, surface and groundwater withdrawals are minimal. One irrigator in the drainage has a water right claim in the sub-watershed for a 10^{th} of a cfs (MWG et al. 1995. This water is apparently diverted from the Okanogan River. Another instance of illegal water withdrawal from Wanacut Creek is currently under investigation (Trevino, personal communication, 2001). Groundwater claims amount to only 9 gpm (MWG et al. 1995). Presently the creek usually does not flow year round in the lower reaches (Hunner, CCT, personal communication, 2001). Base flows at the water quality monitoring station near the mouth of Wanacut Creek are less than 1 cfs. The highest recorded flow at this station is 26 cfs (CCT 2000.)

Water Quality

Wanacut Creek has water quality impairments due to livestock grazing, residential and industrial development, removal of riparian vegetation and grazing practices. The effect of these impairments on water quality in the mainstem Okanogan River has not been established. The Colville Tribe used the Unified Watershed Assessment Categories (UWAC), a part of the EPA Clean Water Action Plan Criteria (EPA 1998) to characterize the condition of the watersheds on the reservation. Wanacut Creek received a Category I rating, indicating that the watershed does not meet clean water and other natural resource goals, and needs restoration.

Fisheries Resources in Wanacut Creek

Brook trout, an introduced species, is the only fish species recorded in Wanacut Creek, both currently and historically (CCT 1997). There may be rainbow trout in the upper reaches (**Figure B-8**) (Marco, personal communication, 2001). The stream is not currently stocked, but the presence of brook trout suggests that it was stocked in the past. There are several culverts in the lower reaches, some of which may be passage barriers to fish (Marco, personal communication, 2001).

Habitat Limiting Factors Assessment of the Wanacut Creek Sub-watershed

The following limiting factors analysis is based primarily on water quality data collected from 1992 to the present (CCT 2000) and observations made by tribal personnel (**Table 5-10**). There are no anadromous species using the drainage, and there are no historical records of anadromy. There are 5 to 10 miles of road adjacent to stream channels in the watershed.

Table 5-10: Limiting Factors Assessment for Wanacut Creek (Reach I: 0.0 - 0.75)

Habitat Pathway and Indicator*	
Water Quality	
Dissolved Oxygen	F1
Stream Temperature	F1
Turbidity/Suspended Sediment	F2
pH	F2
Nutrient Loading/Chemical Contamination	P1
In Channel Habitat	
Fine Sediment (substrate)	F2
Large Woody Debris	DG
Percent Pool	DG
Habitat Access	
Fish Passage	P2
Stream Flow	
Resembles Natural Hydrograph	P2
Impervious Surface	DG
Stream Corridor	
Riparian Vegetation	DG
Stream Bank Stability	DG
Floodplain Connectivity	DG

Support for Limiting Habitat Factor Rankings in the Wanacut Creek Sub-watershed

Water Quality

Dissolved oxygen (DO) values ranged from 7.62 to 14.46 mg/l. Because DO levels during summer months occasionally dropped below 8.0, the creek was rated 'fair' for DO.
Stream temperatures ranged from 0.2 to 26.8 degrees C, with the average summer temperatures over 14 degrees C. The creek was rated Fair for this parameter because 7-day average values did not reach the poor criteria.

Turbidity levels ranged from 0 to 103 NTUs, but turbidities at the upper end of this range were not of long duration. Values were generally less than 20 NTUs, which would qualify the stream as 'good'. Suspended sediment levels are elevated during peak flows (Hunner, CCT. personal communication, 2001). Because of the uncertainty in the duration of events that yield turbidities above 20, the stream was rated as fair for this indicator until further data collection supports altering this rating.

Agriculture and range activity in the basin contribute nutrients to the stream. Wanacut Creek is not on the Washington State 303(d) list.

In-Channel Habitat (fine sediment, large woody debris, percent pools)

There is a data gap in regards to in-channel habitat condition indicators. There are qualitative observations recorded that sediment levels are elevated. There is no data on large woody debris quantities or pool habitat. Rangeland dominates the lower elevations in the watershed, and upper elevations are dominated by dry, sparse forest. Large woody debris levels are likely to be naturally low.

Fish Passage

Habitat access is limited by dewatering in the lower end of the stream during summer months (Hunner, Personal Communication, 2001). Also, as stated above, some culverts in the lower reaches may be passage barriers to fish.

StreamFlow

Land use practices as well as water withdrawal have affected stream flow. Stream flow ranged from 0.1 to 16.6 cfs and average summer flow was below 5 cfs. There are 5-10 miles of road adjacent to streams in the Wanacut watershed.

Channel Condition (riparian habitat, streambank stability, floodplain connectivity)

There is a data gap in regards to stream corridor habitat conditions. Further study of the conditions in this sub-watershed are warranted.

Johnson Creek Watershed Description

Sub-watershed Overview

The Johnson Creek sub-watershed area delineated for this LFA includes the self-contained basins of Fish Lake and Pine Creek (Table 5-1) that do not flow into the Okanogan River (Figure B-10). The Johnson Creek sub-watershed, independent of Fish Lake and Pine Creek, comprises approximately 28,694 acres. When these basins are included, the sub-watershed area comprises 75,659 acres. It is located on the western portion of the Okanogan Watershed with the Okanogan River as its eastern boundary, the Sinlahekin State Wildlife Recreation Area as its northwest boundary, and the Salmon Creek sub-watershed to southwest (Figure B-9). Johnson Creek joins the Okanogan River along its western shore at approximately RM 35, just south of town of Riverside. The Johnson Creek sub-watershed runs parallel to the Okanogan River for about 11 miles. There is a series of 21 lakes found in the south-central terraced region of this sub-watershed (USGS 1984).

The climate within the Johnson Creek valley is semiarid. The highest mountain reaches change to a subhumid, but most of the sub-watershed topography is below 800 m. There are large seasonal temperature extremes and daily temperature and precipitation variations. For example, temperature can range annually between 112°F - -31°F in the valley. Annual precipitation is less than 12.5 inches in the main valley (MWG et al. 1995).

Land Use and Ownership

The majority of land in the Johnson Creek sub-watershed is used for agricultural crops such as apple, cherry or other fruit orchards and hay crops (NWPPC 2001). There is also some rangeland and timber harvesting done in the area. The population of Riverside along the Okanogan in the Johnson Creek sub-watershed has increased 63.7% between 1990 and 1998 (an increase of 223-365 residents; NWPPC 2001).

The majority of land in the Johnson Creek sub-watershed is privately owned agricultural land. In the northwest corner of the sub-watershed approximately 11 mi^2 is WDFW land (the Sinlahekin State Wildlife Recreation Area; USGS 1984).

Topography, Geology & Soils

The Johnson Creek sub-watershed is primarily flat land in the Okanogan floodplain with limited topographic relief relative to the other sub-watersheds in the Okanogan. The highest elevation within the Johnson Creek drainage of the sub-watershed is Dunn Mt., at 5,559 ft, although the mainstem channel of Johnson Creek originates at only about 1,500 ft. Within the forested terrace that supports the 21 lakes, altitudes vary minimally between about 2,300 and 2,500 ft.. The altitudes of the sub-watershed overall range from 1,635 to 2,452 ft., up to 3,270 ft in the northern reaches, and 4,087 ft in a western pocket of the Fish Lake area (USGS 1984). Carter Mountain, in the northeast quadrant of the Pine Creek drainage reaches a height of approximately 3,008 ft. The largest portion of woodland is in the lakes area and lies at a consistent terrace of 750 ft (USGS 1984).

The soils in the Okanogan Basin are formed from glacial activity 10,000 years ago with the Cordilleran ice sheet. The bedrock is primarily granitic andesitic, metamorphosed sedimentary and basaltic rocks. As the glacier melted, it deposited a series of silt, sand, gravel and cobbles (NWPPC 2001). Some tributaries have taken the glacial deposits and deposited them as sand and gravel terraces and plains (MWG et al. 1995). The Johnson Creek sub-watershed is an example of the terraces formed during these processes. Valley soils are comprised of course and well drained glacial soils, which contributes to the leaching into the Okanogan from agricultural lands (USDA 1995). The valley and terrace soils are moderately deep and deep loam, silt loam and sandy loam from glacial outwash, alluvium and lake sediments (NWPPC 2001). Higher elevations are made up of volcanic ash that hold moisture but erode very easily (USDA 1995).

Fluvial Geomorphology & In-Channel Habitat

No formal studies were reviewed that quantified or otherwise characterized fluvial geomorphology or in-channel habitat conditions in the Johnson Creek sub-watershed. The Okanogan Valley and Johnson Creek tributary is broad and flat, except for the lower most 2 - 2 ½ miles where the gradient is very high (NWPPC 2001). This creates large meanders in the river and a mosaic of grass-forbs, shrub thickets, and deciduous trees where agriculture crops and pasturelands have not altered the riparian habitat (NWPPC 2001).

Vegetation and Riparian Condition

No formal studies were reviewed that quantified or otherwise characterized riparian condition in the Johnson Creek sub-watershed. Common native vegetation communities potentially found along the stream-side in the Johnson Creek valley are black cottonwood, quaking aspen, willow spp., maple, cedar and birch (NWPPC 2001). The construction of highways and roads following the river has permanently destroyed stream-side vegetation and created more erosion and runoff.

As a result of these extreme climate shifts, the vegetation found within the valley is made up of a sage and grass community and a minor contribution of bitterbrush (Ecology 1995, NWPPC

2001). However, most of the native shrub-steppe communities have been removed for fruit orchards hay and pastureland (USDA 1995, NWPPC 2001).

Water Quantity/Hydrology

There are 94 surface water right claims within the Johnson Creek/Scotch Creek sub-watershed (Scotch Creek is tributary to Johnson Cr.), and another 91 in the self-contained Pine Creek portion of the sub-watershed. The Johnson Creek/Scotch surface water withdrawal permits amount to a total of 24.5 cfs, or 10,911 acre-ft per year (MWG et al. 1995). In addition to these surface water rights, there are 93 groundwater claims, and 36 permits in the Johnson Creek/Scotch Creek basin. The currently permitted withdrawals would yield 6,766 gallons per minute (15.1 cfs). Thus, there are a total of roughly 40 cfs of surface and ground water potentially removed from Johnson Creek for consumptive use.

No gauges operating on Johnson Creek were identified in the review process for this LFA. Flows at the gaging station closest to Johnson Creek in the mainstem record past flows of 2,907 cfs (2,101,100 ac-ft) at Tonasket. Minimum flows established by Ecology in the Okanogan mainstem near Johnson Creek (Mallott) range from 860 to 3,800 cfs (MWG et al. 1995). Snow melt is the primary source of surface and ground water in the Johnson Creek sub-watershed. Snow melts between May and June when streamflow and groundwater is at its peak (MWG et al. 1995).

Within Johnson Creek, flows have been recently measured by the OCD in monthly monitoring, (May to November 2000) and have ranged from 2.72 to 5.9 cfs in the lower basin near the mouth. In the upper basin, concurrent monitoring measured flows that ranged from 12.8 to 16.6 cfs, averaging 14.4 cfs. The large discrepancy between up-river flows and those near the mouth largely reflect the substantial water withdrawals from this basin.

Water Quality

Historic data on conventional water quality or chemical pollutants in the Chiliwist sub-watershed were not identified. Recent water data have been collected. The main problems associated with the section of the Okanogan, that runs east of the Johnson Creek sub-watershed, is water temperature and sedimentation. Sediment loads flowing from the Similkameen River and other northern reaches increase water temperature and degrade spawning and rearing habitat (MWG et al. 1995). Other sources of sedimentation influx is from irrigation runoff, agricultural activities, overgrazing and logging.

Fisheries Resources in Johnson Creek

All runs of summer/fall chinook, sockeye and summer steelhead occur in the mainstem Okanogan River (**Figure B-9**). No spawning, rearing or migratory activities are known to occur in the Johnson Creek tributary (Okanogan TAG). According to the 1998 study on the Methow and Okanogan Basins, the section of the Okanogan River that is in the vicinity of Johnson Creek contains the third highest density (0.8) of summer chinook redds within the Okanogan (Murdoch and Miller 1999). A total of 21 redds were documented in ground surveys, of the section between the Riverside Bridge and the Tonasket Bridge, completed during the study. There is no documentation of sockeye salmon spawning in this area.

The thermal barriers and irrigation diversions found along the length of the Okanogan adjacent to the Johnson Creek sub-watershed provide migration barriers that may decrease the number of returns. Sedimentation, cover, and high temperatures provide additional constraints to overall survival and reproduction of the salmon population (MWG et al. 1995). Adult sockeye will not migrate in waters higher than 69-70°F (MWG et al. 1995).

The Johnson Creek sub-watershed has two dams within its network of waterways: Fish Lake Dam and Schallow Lake Dam (NWPPC 2001). Both dams are state-owned. The three main species of concern do not utilize tributaries within Johnson Creek, therefore these dams are not of direct concern.

Habitat Limiting Factors Assessment of the Johnson Sub-watershed

The following table (**Table 5-11**) and text discusses the factors affecting fish distribution in the Johnson Creek Sub-watershed. No reach delineations were considered for this draft of the LFA.

Table 5-11: Johnson Creek Limiting Factors Assessment

Habitat Pathway and Indicator*	Limiting Habitat Factor Condition
Water Quality	
Dissolved Oxygen	G1
Stream Temperature	G1
Turbidity/Suspended Sediment	G1
pH	F1
Nutrient Loading/Chemical Contamination	DG
In Channel Habitat	
Fine Sediment (substrate)	DG
Large Woody Debris	DG
Percent Pool	DG
Habitat Access	
Fish Passage	DG
Stream Flow	
Resembles Natural Hydrograph	P
Impervious Surface	G2
Stream Corridor	
Riparian Vegetation	DG
Stream Bank Stability	DG
Floodplain Connectivity	DG

* Pathway in bold, indicator in plain type

Support for Limiting Habitat Factor Rankings in the Johnson Creek Sub-watershed

Water Quality

Dissolved oxygen—The OCD has measured dissolved oxygen in monthly monitoring from lower Johnson Creek with measurements ranging from 9.07 to 12.02 between May 2000 and January 2001 (T. Neslen, OCD unpublished data, [Okanogan TAG]). Values recorded are at saturation, and within the nominal range to receive a good rating for this habitat indicator. The maximum temperature recorded over this time period, expectedly corresponding with the lowest dissolved oxygen reading, was 17.4 degrees, with an average of 11.6 degrees Celsius. Tubidity recorded during the monthly monitoring by the OCD averaged 3.39 NTUs, and did not exceed 5.26. No data have been collected for suspended sediment concentrations in the watershed to our knowledge, but total dissolved solids have ranged from 44 to 237 mg/L. Collectively, these data support good ratings for all the water quality indicators, except pH, which has received a fair rating because of one measurement recorded above 8.5 during the monthly monitoring of all the parameters.

Preliminary Water Quality Monitoring Data in lower Johnson Creek (courtesy of Okanogan Conservation District [OCD])

Sample	Time	Dissolved	pH	Turbidity	Temperature	TDS	Conductivit
		mg/L	units	NTU	celsius	ppm	uS/cm
5/18/00	931	12.8	8.4	6.5	15.0		
6/12/00	1149	10.3	9.0	8.5	13.6	64.0	129.0
7/10/00	1255	9.8	8.9	3.6	12.1	46.0	94.0
8/10/00	928	9.6	8.9	3.6	18.1	*	*
9/21/00	955	10.5	8.9	4.4	11.8	*	*
10/19/00	831	10.7	8.7	3.9	7.8	*	*
11/30/00	838	12.3	8.3	4.4	3.2	255.0	512.0
12/21/00	845	#	#	#	#	#	#
1/18/01	833	14.0	8.7	2.2	0.7	267.0	537.0
	average	11.2	8.7	4.6	10.3	158.0	318.0
	st. dev.	1.6	0.3	2.0	6.0	119.3	239.1

*meter not working; # creek frozen

In-Channel Habitat

In the lower, accessible reach of Johnson Creek the substrate has been reported as armored cobble with no sand or gravels (T. Neslen OCD, [Okanogan TAG]). This armoring may be reflective of the elevated pH in the system, a possible result of concentrated magnesium and carbonate salts from evaporation. The average depth observed by the OCD during the nine months of monitoring in 2000 (when not frozen) was only .270 feet. This depth would restrict the use of the habitat to juvenile salmonids. A quantitative habitat assessment is clearly needed in both upper and lower reaches of Johnson Creek, hence, all the habitat indicators reflective of the quality of in-channel habitat considered by the Okanogan TAG were listed as data gaps.

Habitat Access

The first barrier to Johnson Creek occurs at the culvert underlying highway 97, restricting fish use to the lowermost ½ mile of stream. A canyon reach leading along Conconully Rd may naturally restrict access upstream based on the gradient, although this has not been determined.

Stream Corridor

Habitat indicators of stream corridor integrity could not be rated due to lack of data. Notwithstanding, floodplain connectivity is compromised in several areas of the drainage.

Tunk Creek Watershed

Sub-watershed Overview

Tunk Creek is a 3rd order tributary of the Okanogan River with a total watershed area of approximately 45,585.7 acres (OWC 2000). The 3.7 mile creek (Table 5-2) enters the Okanogan River approximately 5 miles north of the town of Riverside, draining lands east of the river. The basin is generally oriented on an east-west axis. The watershed consists primarily of forest (40%) and rangeland (59.1%). Resource information regarding this sub-watershed is very limited. (OWC 2000).

Land Use and Ownership

There is rural development adjacent to the stream near the mouth, but no urban areas within the watershed. The main land use within the watershed is range, with areas of agricultural including non-irrigated pasture hay and/or feed lots, irrigated hay and orchards. The small acreage landowners allow livestock uncontrolled direct access to the creek. There are roads adjacent to the stream with steep cut banks.

Tunk Creek is a part of the sub-watershed network that includes Wanacut, Omak and Chewiliken Creeks that have a breakdown of grazing lands. Within this group BLM owns 600 acres, CCT owns 86,766 acres, DNR leased lands include 4,160 acres and DNR permit lands include 7,860 acres (NWPPC 2001).

Part of the Scotch Creek Wildlife Area (total acreage is 15,469) owned by WDFW crosses into the Tunk Creek sub-watershed. The Scotch Creek Wildlife Area is a refuge for sharp-tailed grouse. It was converted to cattle grounds and then restored with shrub planting, weed control and grassland seedings (NWPPC 2001). The southeastern portion of the sub-watershed lies within the Okanogan National Forest, approximately 18 mi^2. Half of the area to the southeast is within the Confederated Tribes of the Colville Reservation (USGS 1984).

Topography, Geology & Soils

The Tunk Creek sub-watershed rises gradually from the Okanogan River through a series of broad plateaus, with the headwaters of the main channel initially identifiable at approximately 4,900 ft. The streambed and riparian zones are consistent with much of the remainder of the Okanogan watershed’s geology, in their composition of quaternary alluvium and terraced deposits that will include till, sand, silt and other glacially deposited substrates. Outside of the stream corridor, but within the sub-watershed area the geology is represented by undifferentiated igneous and metamorphic rocks (USGS Okanogan 1:250,000, 1954). The area is dominated by glacially deposited soils that do not tolerate much disturbance. This characteristic increases the potential risk to temperature, fecal coliform, and dissolved oxygen/nutrients, and a moderate risk to turbidity/sediment. The erosion rate within the Tunk Creek sub-watershed is 0.54 ac-ft/mi^2.

Fluvial Geomorphology & In-Channel Habitat

The mainstem stream channel of Tunk Creek is approximately 3.7 miles long (Table 5.2). Stream habitat in the lower mile consists of gravel/cobble substrate with adequate riparian vegetation. Impacts to stream habitat in the lower mile include a ford crossing at approximately 0.2 mile and 4-5 houses located within 15 feet of the OHWM, which pose risk to temperature, dissolved oxygen/nutrients, and turbidity/sediment as well as a limited risk to fecal coliform, instream flows, and toxicity (e.g., from land application of pesticides, etc).

Vegetation and Riparian Condition

Streams in the forested areas of the watershed are receiving good shade. Log skidding has been done in the intermittent streambeds in the sub-watershed. This causes some limited risk to temperature, dissolved oxygen/nutrients, and turbidity/sediment. Within the lower mile of Tunk Creek the riparian vegetation in somewhat intact and consists mostly of a cottonwood/willow overstory. Upstream, the riparian vegetation is interrupted by agricultural development and range use.

Water Quantity/Hydrology

There are 22 permitted surface withdrawals for a total of 1.6 cfs (168 ac-ft/yr). Additionally, there are another 112 surface water claims that could amount to an additional 8.8 cfs (1,554 ac-ft/yr) (MWG et al. 1995). Groundwater withdrawals permitted amount to an additional potential loss of water from the sub-watershed of 74 gpm; groundwater claims amount to a potential withdrawal of 1,728 gpm.

Local knowledge indicates that the lower half to 3/4 mile of the creek is dry throughout the late spring, summer and fall months. In general water is supplied through snowmelt and precipitation. Low flows occur from late summer through winter (NWPPC 2001).

Recent monitoring by the OCD in the upper Tunk Creek watershed measured flows ranging from 0.83 to 17.7 cfs, with peaks occurring in May or June (T. Neslen OCD, [Okanogan TAG]). Baseflows in the summer and fall appear to fluctuate between around 1 to 1.5 cfs. Data from the confluence area were not available.

Water Quality

Dissolved oxygen measurements in upper Tunk Creek between May 2000 and January 2001 ranged from 9.4 to 13.2 (T Neslen OCD, [Okanogan TAG]). Temperature values recorded in upper Tunk Creek reached a maximum of 15.9 degrees celsius in the July monitoring by the OCD. The pH values averaged 8.56, but did not exceed 9.0 in the upper basin. Turbidity recorded over these time points was maximal in May (9.8 NTU), and averaged just below 5 NTUs. These turbidity data, slightly above background, suggest there may be a potential problem with sediment recruitment into the system.

As depicted below, water quality in lower Tunk Creek reflects a slight decline in quality over that measured in the upper part of the basin. In particular, there was a slight increase in pH and turbidity.

Nutrient indicators of ammonia, nitrates and phosphates, as well as metal elements have been analyzed in the upper and lower Tunk Creek basin as well. None of the measurements recorded by the OCD exceeded the 'good' thresholds adopted by the TAG or other aquatic risk thresholds.

Preliminary Water Quality Data from Lower Tunk Creek 2000/01 (OCD unpublished data)

Sample Date	Dissolved Oxygen	pH	Turbidity	Temp.	TDS	Conductivity
	Lower Tunk Creek					
	mg/L	units	NTU	celsius	ppm	uS/cm
5/9/00	11.2	7.8	14.8	7.8	nr	nr
6/13/00	9.2	8.6	13.0	10.4	27.0	54.0
7/11/00	10.3	8.8	0.5	14.7	33.0	66.0
8/15/00	9.7	8.6	0.4	11.6	*	*
9/12/00	9.3	8.9	2.7	11.4	*	*
10/10/00	10.5	8.8	0.5	7.8	*	*
11/14/00	13.8	8.5	0.8	0.6	*	*
12/12/00	16.7	9.0	0.8	0.2	238.0	469.0
1/9/01	16.5	8.3	0.9	0.5	213.0	424.0
Average->	11.7	8.6	3.8	7.2	127.8	
St Dev->	3.0	0.4	5.8	5.5	113.4	224.0

Fisheries Resources in Tunk Creek

Two of the main species of concern (chinook and sockeye) do not migrate or spawn in Tunk Creek. Steelhead have a current distribution to McAllister Falls, approximately ¾ to 1 mile from the Okanogan confluence. The use of lower mile Tunk Creek below the falls is predicated upon adequate flows, thus, it is generally accessible to anadromous salmonids during the winter and spring months.

Resident rainbow trout occupy habitats upstream of the anadromous zone.

Habitat Limiting Factors Assessment of the Tunk Creek Sub-watershed

Table 5-12 following table discusses factors affecting salmonid fish distribution in the Tunk Creek sub-watershed (**Table 5-12**).

Table 5-12: Tunk Creek Limiting Factors Assessment

Habitat Pathway and Indicator	Limiting Habitat Factor Ranking	Limiting Habitat Factor Ranking
	Reach 1—Mouth to McAllister Falls	**Reach 2—Upstream of McAllister Falls**
Water Quality		
Dissolved Oxygen	G1	G1
Stream Temperature	G1	G1
Turbidity/Suspended Sediment	G1	G1
pH	F1	F1
Nutrient Loading/Chemical Contamination	G1	G1
In Channel Habitat		
Fine Sediment (substrate)	DG	DG
Large Woody Debris	DG	DG
Percent Pool	DG	DG
Habitat Access		
Fish Passage	G1	DG
Stream Flow		
Resembles Natural Hydrograph	F2	F2
Impervious Surface	G1	G1
Stream Corridor		
Riparian Vegetation	DG	DG
Stream Bank Stability	DG	DG
Floodplain Connectivity	DG	DG

Aeneas Creek Watershed Description

Sub-watershed Overview

Aeneas Creek, enters the Okanogan River along the west side at approximately river mile 50. The subwatershed comprises approximately 0.41% percent of the total Okanogan watershed (OWC 2000). Aeneas Creek flows in a southeasterly direction from the slopes of Aeneas Mountain (3,106.5 m el.) to the Okanogan River (approx. 900 ft el.). It has a total stream length of, and flows through an area referred to as the "lime belt region." The affect of this lime belt land-type region is evident by the accumulation of calcium carbonate along the streambed channel.

Land Use and Ownership

The majority of the 6,890 acre Aeneas Creek watershed is privately owned. Land use consists primarily of rural development, farming and ranching. Land type consists primarily of rangeland (66%) forested lands (26.5%), and cropland (6.6%) (OWC 2000). Most crops grown are hay or alfalfa. Ranching occurs at a relatively small scale, with approximately 400 head grazing within the watershed annually (L. Andrews, personal communication, 2001). Of the 400 head, approximately 300 cattle graze the lower elevation range during the spring (mid-April to June). The remaining 100 head graze within the basin throughout the year.

Topography, Geology and Soils

According to soils mapping conducted by the USDA NRCS, soils in the Aeneas Cr. sub-watershed are principally of the WA 346 type. (SCS 1980).

Fluvial Geomorphology and In-Channel Habitat

Based upon reconnaissance-level surveys conducted by the Colville Confederated Tribes in May of 1998, the channel condition from the Pine Creek road bridge (~ RM 2) downstream to the confluence is undisturbed except for isolated areas where the stream has been crossed by roads, driveways or routed through irrigation pipes.

Vegetation and Riparian Conditions

The majority of the vegetation type in the Aeneas sub-watershed is shrub-steppe. In the upper basin, a low density forest of Ponderosa pine is present.

Streambank erosion was evident in two major areas during summer 1998 surveys conducted by the Colville Confederated Tribes. The first section, approximately 1/8 of a mile of streambank, is located between the natural falls (~ RM 0.75) and Pine Creek road. The second section, a total length of approximately two river miles, is located from the Pine Creek Road crossing to near Lemanaski Lake. The cause of this erosion appears to be from overgrazing by livestock as depicted by the absence of riparian vegetation, hoof shear, and streambank collapse. Bank erosion between the falls and Pine Creek Road is currently being addressed through a fencing project funded in part by the local Regional Fisheries Enhancement Group. In areas not otherwise impacted, riparian habitat appears to be functionally representative of undisturbed conditions for the ecoregion.

Water Quantity/Hydrology

Aeneas Creek is primarily spring fed, thus there is little seasonal variation in the hydrograph relative to other Okanogan tributaries influenced primarily by snowmelt runoff. A weathered section of 100 ft of corrugated metal pipe currently conveys water in the lower one half mile of the creek, downstream of the highway 7 bridge (Tonasket:Oroville westside rd), but returns it to the creek. The presence of this pipe suggests that flows from Aeneas Creek were formerly used for irrigation.

Water Quality

Water temperature data indicates Aeneas Creek is contrastingly cooler compared to water temperature in the Okanogan River. In a long term water temperature monitoring study conducted by the Colville Confederated Tribes between 3/16/00 and 2/20/01 the maximum temperature recorded at the mouth of Aeneas Creek was 65.7 ^{o}F (18.7 ^{o}C) which compared to a maximum of 83 ^{o}F, (28 ^{o}C) recorded over the same period in the Okanogan River in Malott 23.31 (C. Fisher, unpublished data).

Turbidity increases rapidly in the creek following summer thunderstorms and rapid snow melt. The causes of this turbidity appear to be related to bank erosion of riparian habitat upstream of the falls, in the locations previously discussed .

There is no evidence to suggest that other conventional water quality parameters (e.g., dissolved oxygen, pH) are compromised from their natural conditions by land management in the sub-watershed.
No data were available to evaluate whether nutrient contributions or contaminants effect water or sediment quality in the sub-watershed to a degree that would affect the use of the sub-watershed by salmonids.

Anadromous Salmonid Fisheries Resources in Aeneas Creek

Historical and existing stocks

Information regarding the aquatic resources of Aeneas Creek is limited. Most information that does exist originates from reconnaissance surveys and anecdotal observations (L. Hoffman 1998, C. Fisher 1998). A private trout farm once operated in the system upstream of the falls approximately 1 mile above the Pine Creek Rd bridge crossing (~ RM 3). It is not known whether this was simply a grow-out facility, or a complete hatchery operation.

Long-time resident of the basin, Jerry Jones, has stated cutthroat trout inhabit Aeneas creek upstream of the falls and a variety of size classes have been caught. Rainbow and eastern brook trout have been observed downstream of the falls (J. Jones, personal communication to C. Fisher, 4/6/01) (**Figure B-12**). The observation of multiple size classes suggests that natural reproduction is occurring within the basin. Evidence of cutthroat trout spawning in the basin supports the conclusion that water quality is adequate to support the spawning of other salmonid species, if other habitat factors (e.g., substrate size, etc.) were suitable. Recent concern has been raised by local landowners, however, that the cutthroat trout population is not as abundant as formerly thought.

Fish Passage and Habitat

Two adult fish passage barriers were identified during joint surveys conducted by the Colville Confederated Tribes and Washington Department of Fish Wildlife during the summer of 1998 (Okanogan TAG). The lowermost barrier is a concrete box culvert located approximately ¼ mile upstream from the mouth. In 1998 this culvert was reviewed for possible replacement for fish passage by the WDFW hydraulic engineers participating in the summer survey (B. Heiner and L. Hoffman); at that time costs were considered prohibitive with respect to the potential habitat gained from the culvert replacement action. The second barrier is a natural falls located approximately 3/4 mile from the mouth. Although these barriers to adult fish passage also constitute barriers to juvenile fish, additional potential velocity and jump-height passage barriers to juvenile salmonids have not been addressed in the watershed.

During the spring of 2000 a picket-weir trap was installed near the mouth of Aeneas Creek and monitored for approximately 8 weeks to address the potential use of the this sub-watershed by steelhead trout. During the sampling period no adult steelhead were collected. During 1999 adult sockeye salmon were implanted with radio-tags to determine travel time through the Okanogan River. Adult sockeye were located for short periods of time at the confluence of Aeneas Creek during the migration from the mouth of the Okanogan River to Lake Osoyoos (S. Bickford 2000). It was presumed adult sockeye salmon were utilizing the confluence area of Aeneas Creek as a thermal refuge during their migration up the Okanogan River.

Habitat Limiting Factors Assessment of the Aeneas Sub-watershed

The assessment of limiting factors in Aeneas Creek considered three distinct reaches as described below (**Table 5-14**). Habitat conditions were rated in each reach in accordance with the criteria developed by the TAG, as previously described.

Table 5-14. Aeneas Creek Limiting Factors Assessment

Attribute Considered	0-0.25 miles Reach 1	0.25-0.75 miles Reach 2
Water Quality		
Dissolved Oxygen	G1	G1
Stream Temperature	G1	G1
Turbidity/Suspended Sediment	G2	G2
Nutrient Loading	G2	G2
In Channel Habitat		
Fine Sediment (substrate)	F2	F2
Large Woody Debris	DG	DG
Percent Pool	DG	DG
Habitat Access		
Fish Passage	P1	DG
Streamflow		
Resembles Natural Hydrograph	G2	G2
Summer Flow Level	G2	G2
Winter Base Flow	G2	G2
Impervious Surface	G2	G2
Stream Corridor		
Riparian Vegetation	G2	F2
Streambank Stability	G2	F2
Floodplain Connectivity	G2	G2

Support for Limiting Habitat Factor Rankings in the Aeneas Creek Sub-watershed

Reach 1: RM 0 to ~0.25-mouth to impassable box culvert barrier underlying Tonasket-Oroville Rd

Water Quality

Water quality in this reach is affected by upstream influences nearly completely. Backwater from the Okanogan river could affect approximately the lowermost 100 ft of water quality in the creek.

Turbidity and suspended sediment loads from upstream are visible for extended durations. Other conventional water quality parameters are presumed to be functioning properly because of the predominant groundwater influence in the system and naturally high alkalinity.

In-Channel Habitat

There are no quantitative data available to address substrate sedimentation, large woody debris, or percent pools in this reach.

Habitat Access

Within the reach access is not restricted until the upstream end of the reach (the impassable box culvert).

Flow

There is no evidence of hydrograph change in the sub-watershed with respect to either changes in peak flows, base flows or flow timing.

Channel Condition

Channel conditions in this reach are generally stable, with no evidence of streambank erosion or loss of floodplain connectivity. Riparian conditions exhibit a managed herb layer (grasses) which may be either mowed or otherwise controlled by herbicide application (plate 1). The shrub layer in this reach is sparse and the tree layer is effectively absent, thus, wood recruitment from riparian vegetation is not currently occurring in this reach.

Reach 2: ~ RM 0.25 to 0.75—impassable box culvert to natural falls

Water Quality

Water quality in this reach is affected by upstream influences, however, bank erosion within the reach is contributing sediments, causing visible turbidity. Although no quantitative data exist, other water quality parameters are thought to be functioning properly.

In-Channel Habitat

No data, data gap.

Habitat Access

There are no habitat access problems for adult fish within this reach. Passage for juvenile salmonids within this reach is not known.

Flow

There is no evidence of an altered hydrograph in this reach of the system. Groundwater dominance of flows buffers against impacts from altered channel conditions.

Channel Condition

Riparian conditions are generally intact except where overgrazing has impacted the stream corridor. Floodplain connectivity is not affected by channelization.

Reach 3: RM 0.75 to Source—all habitat upstream of the natural falls

Water Quality

Turbidity is generated in this reach by an extensive corridor of eroding banks. Other conventional water quality parameters are assumed to be functioning properly, but no formal data exist with which to compare to the criteria established by the TAG. Water quality in this reach is affected by overgrazing along riparian corridors, however, bank erosion within the reach is contributing sediments, causing visible turbidity. Although no quantitative data exist, excessive nutrients and contaminants in this sub-watershed are not known to be a problem.

In-Channel Habitat

No data, data gap.

Habitat Access

No data, data gap.

Flow

No data, data gap.

Channel Condition

No data, data gap.

Reach 1

Aeneas Creek is a small stream, approximately a bankful width of 10 feet at the mouth. Two active beaver dams exist within Reach 1 downstream of the highway 7 bridge. It appears that one beaver pond was formerly utilized as a reservoir to withdrawal water for irrigation. Currently the pipe routes about 20% of the flow downstream approximately 50 feet where it spills back into the channel.

State highway 7 crosses Aeneas Creek at approximately 0.5 mile. Between the mouth and highway 7, an apple orchard exists along north side of the creek. Agriculture, along with the beaver activity, has likely influenced the limited riparian vegetation along both sides of Aeneas Creek downstream of the highway 7 bridge. At the downstream side of the highway 7 crossing there are rubble and spoils in the stream channel, likely from the concrete culvert installation. These spoils, along with the change in streambed elevation has created a barrier to upstream fish passage. Observation of the concrete boxed culvert indicates the culvert would likely be a velocity barrier to fish passage as well.

Between the highway bridge and the falls (approximately 0.5 mile), the riparian vegetation is mature and in areas virtually impenetrable. Human-induced effects in this area appear to be negligible.

Reach 2

Within Reach 2 the area is interspersed with private residences. Along this reach there are areas of concentrated livestock use. The livestock effects upon Aeneas Creek include hoof shear, bank collapse and loss of riparian vegetation. Along one reach there is a livestock feeding area. This reach is approximately 300 feet long and is basically absent of all riparian vegetation. area where there is a limestone area. There are also isolated areas where farming (hay, alfalfa, etc.) are being conducted and reducing bank stability and riparian vegetation.

Several springs contribute to the flow of Aeneas Creek. These springs provide a constant cold-water source to Aeneas Creek, so much so that formerly there was a fish hatchery located near the headwaters of Aeneas Creek, which raised trout.

Whitestone Creek Watershed Description

Sub-watershed Overview

The Whitestone Creek Watershed encompasses six main bodies of water (from north to south): Blue Lake, Wanacut Lake, Spectacle Lake, Whitestone Creek, Whitestone Lake, and Stevens Lake (DOI 1976). The Okanogan River flows along its eastern border, running 33.1 km along the subbasin from Oroville to Tonasket (Murdoch and Miller 1999). The Whitestone Creek subbasin is an island surrounded by larger subbasins of the Okanogan watershed. To the west is the Similkameen River subbasin, to the southwest is the Aeneas Creek, to the southeast is the Siwash Creek, to the east is the Antoine Creek and to the northeast is the Tonasket Creek.

Land Use and Ownership

Agriculture and livestock production are the two main economic sources to Okanogan County and Whitestone Creek subbasin specifically (LMEA 1997). Native vegetation is cleared most often in the flood plains and lower terraces for apple (*Malus*) orchards (DOI 1976). The main crop produced is apple, and other fruit trees such as cherry and pear, and crops such as wheat, barley, oats, corn and hay are additional agricultural uses of the land (LMEA 1997).

Topography, Geology & Soils

The rock types found within the glacial valley are Permian to Triassic metasediments, which include argillite, quartzite, and marble (DOI 1976). Soils originate from alluvial and glacial outwash deposits with a high percentage of silt and sand (DOI 1976). The terraced land surrounding the Okanogan River are coarse deposits of glacial outwash with a consistency of cobble and gravel (DOI 1976). The texture of the terraces range from loamy fine sand, fine sandy loam and very fine sandy loam (DOI 1976).

Fluvial Geomorphology & In-Channel Habitat

The subbasin valley is made up of glacially-formed terraces and narrow flood plains, surrounded by mountainous terrain (DOI 1976). The land lining the Okanogan River to the east is a flood plain and gently rises to sloping and undulating terraces (DOI 1976). Elevation from the Okanogan River in the east to the surrounding mountains gradually increases to 1000 ft. The majority of the agricultural lands in this region range from 50 to 600 ft above the river (DOI 1976).

Vegetation and Riparian Condition

Whitestone Creek subbasin is positioned in the rain shadow of the Cascade Mountains. The resulting low annual precipitation (12.3 inches) (www.worldclimate.com, 5/4/01) creates a semiarid region, evident by its transition between shrub-steppe and pine forest (DOI,1976). Along the riverbanks and the flood plain the dominant tree species is black cottonwood (*Populus trichocarpa*). The lowest elevation above the river, on the eastside of the subbasin, is a big sagebrush (*Artemisia tridentata*)-blue bunch wheatgrass (*Agropyron spicatum*) vegetation association (DOI 1976). Above this shrub network at higher elevations to the west are the cutleaf sagebrush (*Artemisia tripartita*)-Idaho fescue (*Festuca idahoensis*) zone (DOI 1976). Above the sagebrush-fescue association is the lower timberline of ponderosa pine (*Pinus ponderosa*).

Water Quantity/Hydrology

Water supply

Whitestone Creek Subbasin rests in a valley surrounded by mountainous reaches. The majority of the water that flows from the higher elevations to form the lake and river system of the subbasin is from snowmelt (WDFW 1990). Annual precipitation to this area does not contribute much water (12.3 inches) (www.worldclimate.com, 5/4/01).

Streamflow

The Okanogan River flows along the eastern edge of the Whitestone Creek subbasin. Although no information is available for Whitestone Creek flows specifically, the range of flow from the Okanogan north to south of the subbasin is representative of the smaller tributary trends. The Okanogan River at Oroville (located at the north end of Whitestone Creek subbasin) has a flow of 129 ft^3/s, and at the lower reach of the Whitestone Creek subbasin near Tonasket, the Okanogan River flows are 887 ft^3/s (http://wa.water.usgs.gov, 4/23/01).

Water Quality

The general trend of lower alkalinity values in the northeastern portions of Washington hold for both Spectacle and Whitestone Lakes. In a 1997 report by Ecology, Spectacle Lake supported an alkalinity range of 77-70 mg/l CaCO3 and Whitestone Lake a slightly higher range of 110-114 mg/l CaCO3 (Ecology 1997).

Aquatic weeds in the Spectacle and Whitestone Lake areas are of interest. In 1997 Whitestone Lake was found to house the noxious weed species *Myriophyllum spicatum* (Eurasian milfoil) and *Lythrum salicaria* (purple loosestrife); Spectacle Lake did not support any listed noxious plants of concern (Ecology 1997). The plant species found to be regularly supported in both Spectacle and Whitestone Lake was *Zannichellia palustris*, an aquatic plant with mid-range alkalinity level tolerance.

The majority of the sediment load into the Whitestone Creek subbasin originate from surface erosion in the Similkameen River two miles to the north (WDFW 1990). High sediment loads and a low gradient channel accumulate sediments which causes thermal heating (WDFW 1990). Thermal barriers form in areas of accumulated sediment blocking anadromous fish runs. For example, chinook salmon require temperatures below 66º F before they migrate from the Columbia into the Okanogan in September (DOI 1976). Sockeye salmon migrate between July and August and cannot travel through waters in excess of 66º F to 68º F (DOI 1976). A high influx of sediments also degrade spawning habitat (WDFW 1990).

Anadromous Salmonid Fisheries Resources in Whitestone Creek

This northern section of the Okanogan River and related tributaries is part of the river structure that represents an upper terminus of anadromous salmonids in the Columbia River Basin (WDFW 1990) (**Figure B-13**). These water systems of the Okanogan support anadromous species such as summer chinook (Oncorhynchus tshawytscha), sockeye (Oncorhynchus nerka), and Coho salmon (Oncorhynchus kisutch), and steelhead trout (Salmo gairdneri) (DOI 1976).

Summer chinook spawn from about early October to early November in the Okanogan and related tributaries. The 33.1 km of the Okanogan River that runs along the Whitestone Creek subbasin's eastern border supported the highest density of summer chinook redds throughout the Okanogan River in 1998 (Murdoch and Miller 1999). The ground and aerial survey taken from September to November counted a total of 29 redds, 33% of the total found that year (Murdoch and Miller

1999). The 1998 study estimated that, based on a 3.6 fish/redd ratio, 317 Redds expanded through tributary escapements. Compared to the total of 88 Redds found in the Okanogan, the tributaries potentially play a more dominant role in summer chinook spawning than the Okanogan itself.

The main run of the Okanogan River through the Whitestone Creek Subbasin is the majority of the chinook, sockeye and steelhead migration through the region (**Figure B-13**). Steelhead are shown to branch off into the Whitestone Creek at the main tributary to the Okanogan River, but no other documented records show a further extent for either chinook or sockeye **Figure B-13**).

Habitat Limiting Factors Analysis of the Whitestone Creek Sub-watershed

The following information addresses the factors affecting fish distribution in the Whitestone Creek sub-watershed (**Table 5-15**).

Table 5-15: Whitestone Creek Limiting Factors Assessment

Attribute Considered	Anadromous potential, Water Quality concerns
Water Quality	
Dissolved Oxygen	
Stream Temperature	
Turbidity/Suspended Sediment	
Nutrient Loading	
In Channel Habitat	
Fine Sediment (substrate)	
Large Woody Debris	
Percent Pool	
< 2%	
2-5%	
>5%	
Habitat Access	
Fish Passage	
Stream Flow	
Resembles Natural Hydrograph	
Impervious Surface	
Stream Corridor	
Riparian Vegetation	
Stream Bank Stability	
Floodplain Connectivity	

Support for Limiting Habitat Factor Rankings in the Whitestone Creek Sub-watershed

Bonaparte Creek Watershed Assessment

Sub-watershed Overview

The Bonaparte Creek watershed encompasses 102,120 acres of mixed ownership. The acres are a mixed ownership as follows: Private ownership, 59,000 acres (58%); Washington Department of Natural Resources, 9000 acres (9%); Bureau of Land Management managed lands, 1000 acres (1%); and the remaining 33,000 acres (32%) are managed by the US Forest Service (USFS).

Bonaparte Creek enters the Okanogan River in the city of Tonasket, Washington, at River Mile (RM) 56.7 of the Okanogan River. The watershed at its longest axis is approximately 20 miles long; its widest point is approximately 17 miles wide.

Land Use and Ownership

Private lands adjacent to Bonaparte Creek are used primarily as rangelands, home sites, or for agriculture (hay fields). Primary use of USFS, DNR and BLM lands are timber production and/or livestock allotments.

State Highway 20 runs parallel to Bonaparte Creek for approximately 15 miles, and County Road 4953 runs parallel to the creek for almost 6 miles. There are many more roads adjacent to streams in this watershed.

Topography, Geology & Soils

Tonasket, Antoine, Siwash and Bonaparte watersheds are all part of the Okanogan sub-continent (Alt and Hyndman 1984). The Columbia River forms the eastern and southern boundaries. The western boundary, the Okanogan River valley, is geologically known as the Okanogan trench. The Okanogan sub-continent extends hundreds of miles north into British Columbia, Canada.

The Okanogan sub-continent was an island about the size of California that crashed into the Kootenay Arc (which was then the western edge of the continent), about 100 million years ago. Following this "docking" of the sub-continent came the filling of what was then the "coastal area" on the west edge of the Okanogan sub-continent, the Okanogan trench (now the Okanogan Valley) (Alt and Hyndman 1984). The intersection of these two geologic features (the Okanogan sub-continent and the Okanogan trench) appears to be where barriers of waterfalls or high gradient stream channels occur. These barriers preclude upstream migration of anadromous salmonids.

The elevation of the confluence of Bonaparte Creek with the Okanogan River is 880 feet. The highest point in the Bonaparte Creek watershed is Bonaparte Mountain at 7,240 feet. The Bonaparte Watershed is oriented on an east to west axis.

Tectonic uplifting: continental glaciations, and volcanic ash deposition all played major roles in shaping the existing topography and soils characteristics of this watershed.

Continental glaciations have had the greatest impact. Large areas of exposed rock and shallow soils were left as a result of the flow and retreat of the Okanogan and Sanpoil lobes of this cordilleran ice sheet. Bedrock is overlain by Quaternary glacial till outwash and glaciolacustrine sedimentary deposits of varying thickness.

The upper elevation bedrock is tertiary medium to coarse grain grandiorite and granite of the Mt. Bonaparte pluton.

The lower elevations are underlain with pre-tertiary banded gneiss and schist of the Tonasket gneiss. Both rock types are included in a metamorphosed and structural uplift called the Okanogan gneiss dome (USFS 1998 and 1999).

Fluvial Geomorphology & In-Channel Habitat

Due to channel alterations, more water is transported during spring runoff and storm events than before. By increasing the force of the stream, affects to channel morphology and channel stability have occurred. As mentioned before, this has had the great impact to water quality. Large amounts of sandy sediment are transported to the lower reaches of Bonaparte Creek and into the Okanogan River from the channel erosion occurring between river miles 5.1 to river mile 10.8.

Riparian Vegetation and Riparian Condition

Streamside vegetation has been altered greatly in the reaches where land uses are agricultural, and pastureland in the upper portion. Home sites, and commercial uses in the Tonasket area have altered the lowest reach.

In-channel large woody debris appears to be lacking in much of Bonaparte Creek. Non-forested habitat types, rock and shrub steppe, occur frequently along Bonaparte Creek. It is unlikely large woody debris recruitment would occur from those sites.

Water Quantity/Hydrology

The following is from the Tonasket Watershed Assessment (USFS 1998) hydrology section and applies to Bonaparte Creek watershed: Tonasket Creek watershed is characterized by high spring runoff due to melting snowpack that accumulates in late fall and the winter months. Summer and fall runoff is low, fed by the release of stored water from riparian areas in floodplains, seeps, and springs at the headwater tributary streams.

Stream flow timing has changed through channel alterations in headwater tributary streams and on Bonaparte Creek. These alterations have cut the channels deeper resulting in reduced ground water recharge.

The road network has influenced the timing of run-off. Several roads intercept ground water and re-routes the water overland through ditches. This interception reduces the amount of late season flow by routing water from storm and melt water directly to stream channels. Using the USFS existing road layer, seventy-eight miles of road (20% of roads in watershed) were found to be within 100 meters of the one hundred, ninety miles of streams. Surface water also reaches these road drainage ways and leaves more quickly than if it were to recharge ground water storage areas.

Altered floodplains exceed 300 acres. These areas could hold more water than at present, and stored it for later release.

Irrigation withdrawals from the creek are made from Bonaparte Creek and its tributaries. Uses of water from withdrawals are irrigation of hayfields, stock watering and household water. Five documented water withdrawals were found from two sources. permit is for The Bonaparte Water Users Association has water right to 1080 acre-feet of water from Bonaparte Lake. (An unpublished memorandum, USFS 1967) Four other withdrawals from Bonaparte Creek are documented on the Washington State Department of Ecology's Water Rights Tracking web page http://www.ecy.wa.gov/programs/wr/info/wrats/Wria-ok.htm.

Water Quality

Due to channel alterations more surface water flows downstream during spring runoff and storm events. This increase in stream energy erodes areas where bank stability is poor, and degrades the water quality by increasing the amount of fine sediment.

Functioning depositional areas exist on Bonaparte Creek to allow these fine sediments to fall out and deposit on the streams banks and channel bottom. The "new" soil is then held in place by opportunistic plants. Identified functional depositional areas are approximately at river mile 10.8, 12.9, both near the confluence of Peony and Bonaparte Creek. In Upper Bonaparte Sub-watershed functioning depositional areas exist on Bonaparte Creek approximately at river mile 20.0, downstream from intersection of Bonaparte Lake road and Hwy. #20, river mile 23.0, confluence with Lightning Creek, river mile 24.5, non-channeled portion of Bonaparte Meadows. Peony Creek has two depositional areas. Both are located near Aeneas Valley road crossing (**Figure 5-1**).

Figure 5-1. These areas effectively improve water quality by slowing the stream.

Water quality discussion will be limited to the portions downstream of this last depositional area. Water quality is altered down stream of River Mile 10.8. Discussion of water quality will be limited to the reaches between river miles 0.00 and 10.8, focusing on the limiting factors to salmon, steelhead and bull trout production.

Large amounts of fine sediment are produced downstream of the last functioning depositional area. A large area beginning at river mile 5.1 and continuing for more than a 5 miles upstream is down cutting, and has created tall vertical banks confining the stream to a trench. The most significant example of this is located within a riparian enclosure approximately at river mile 5.1 to 6.3. This area was identified by the OCCD for project work to reduce sediment delivery to the Okanogan River in 1987. Here the stream still has 10-foot tall bare vertical upper banks. Sediment generating from this portion of the stream is carried to anadromous fishes redds below.

Downstream of from the sediment source Bonaparte Creek flows through a narrow canyon. Within the canyon the creek flows over 3 large waterfalls on its way to the Okanogan River. Sufficient mixing occurs in this area to replenish oxygen content in the water for fisheries below.

Water Quality is altered again in the lowest reach of Bonaparte Creek. Here urban impacts of street and parking lot runoff, combined with septic leach fields and apple shed effluents alter the water quality.

Bonaparte Creek is not on the Washington State List of Threatened and Imperiled Waterbodies (the 303d list) (M. Linden, personal communication, 2001).

Anadromous Salmonid Fisheries Resources of Bonaparte Creek

Anadromous fisheries resources are restricted to the lower 1.0 mile of the Bonaparte Creek sub-watershed due to an impassible waterfall (**Figure B-14**). By estimate less than 100 square meters of suitable spawning habitat occurs in Bonaparte Creek. A large area, 200 square meters, with suitable spawning substrate is 300 meters downstream in the Okanogan River.

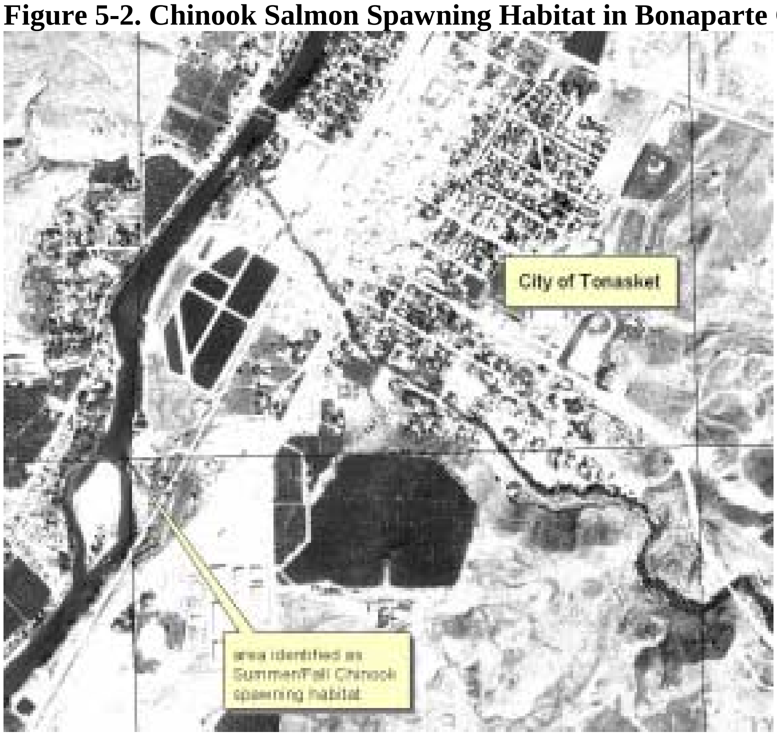
Steelhead

No data is available about the use of Bonaparte Creek for rearing or spawning of Upper Columbia River Summer Steelhead. It is assumed that passage of adults is not restricted up to river mile 1.0, at the first falls.

Chinook Salmon

Summer/fall chinook salmon are known to use the mainstem Okanogan River as well as the Similkameen River to Enloe Falls (**Figure 5-2**). . The mainstem Okanogan River is used for migration northward to Canadian waters. Most of the known summer/fall chinook spawning areas are in the Similkameen River. It is unlikely that chinook salmon use Bonaparte Creek, as flows in the fall are less than 5 cubic feet per second (cfs), but spawning has occurred in the mainstem Okanogan River below Bonaparte Creek. Note about the spawning below the Bonaparte creek portion talk to Linda Hoffman.

Figure 5-2. Chinook Salmon Spawning Habitat in Bonaparte Creek.



Spring Chinook Salmon

Adult spring chinook salmon (Oncorhynchus tshawytscha) in the Upper Columbia Basin are not currently known to use the Okanogan River. The temperature regime at the time spring chinook salmon spawn in the mainstem Okanogan River is too high for successful spawning and rearing. Water temperatures are elevated due to irrigation water withdrawals (K. Williams and J. Spotts, personal communication). In their Endangered Status of One Chinook Salmon ESU Final Rule (U.S. Federal Register, 1999), the National Marine Fisheries Service excluded the Okanogan River from their Endangered species listing for the Upper Columbia Evolutionarily Significant Unit

(ESU) of spring chinook salmon. The Okanogan River was excluded from the listing because spring chinook adults are collected as they migrate upstream at Wells Dam on the Columbia River, approximately 20 miles downstream of the confluence of the Okanogan River. The adult salmon are transported to the Winthrop National Hatchery in Winthrop, Washington, and are spawned there. The eggs and resulting fry are raised at the hatchery and later released into the Methow River.

Sockeye salmon

Sockeye salmon are known to use the mainstem Okanogan River as a migration pathway to their spawning areas in Lake Osoyoos and the upstream reaches of the Canadian Okanogan River. Sockeye salmon are not known to use Bonaparte Creek.

Bull trout

There are no data or anecdotal information indicating bull trout ever were, or that bull trout currently are, in the Bonaparte Creek watershed. Data that does exist suggests that bull trout did not exploit the Okanogan River north of the city of Omak, approximately 30 river miles down-river of the confluence of Bonaparte Creek with the Okanogan River (K. Williams, personal communication). The Okanogan River is not suitable habitat for bull trout due to the bull trout requirement of very cold, clean waters with clean gravel/cobble substrate for successful spawning and rearing.

Scott and Crossman (1973) reported that bull trout are not present within the Canadian Okanogan River system.

Habitat Limiting Factors Analysis of the Bonaparte Creek Sub-watershed

Bonaparte Creek was divided into four reporting units (reaches) addressing potential limiting factors to salmonid production in Bonaparte Creek and in the Okanogan River.

Reach 1 (from the mouth of Bonaparte Creek to River Mile 1.0) is considered usable anadromous salmonid habitat provided that there is adequate flow. Reach 1 ends at the base of a waterfall that is a natural passage barrier.

Reach 2 (River Mile 1.0 to RM 4.8) includes the steep gradient channel. This reach ends at State Highway 20 bridge. The channel gradient is greater than 5% in this reach. This reach is considered a transport reach, but is not considered to be usable habitat for anadromous fish because of the natural barriers.

Reach 3 (River Mile 4.8 to RM 10.8) Water Quality is greatly altered in this reach. This reach is the major source of fine sediment delivered to the downstream fishery.

Reach 4 (River Mile 10.8 to Bonaparte Lake) Water quantity, timing and amount, and water quality, temperature, are important factors to track in this reach.

The following rankings reference habitat criteria accepted by the Okanogan TAG group as most relevant to the production potential of anadromous salmonid fishes in the Okanogan (**Table 5-16**).

Table 5-16: Bonaparte Creek Limiting Factors Assessment

Attribute Considered	Anad potential Reach 1	Water Quality Reach 2	Water Quality Reach 3	Water Quality Reach 4
Water Quality				
Dissolved Oxygen	G1	G2	D.G.	F1
Stream Temperature	G1	D.G.	D.G.	G1
Turbidity/Suspended Sediment	F1		D.G.	G1
Nutrient Loading	?	D.G.	D.G.	?
In Channel Habitat				
Fine Sediment (substrate)	P2	P2	P2	D.G.
Large Woody Debris	P2	P2	P2	D.G.
Percent Pool				
< 2%	D.G.		D.G.	D.G.
2-5%	D.G.		D.G.	D.G.
>5%		D.G.		D.G.
Habitat Access				
Fish Passage	F2	N/A	N/A	N/A
Stream Flow				
Resembles Natural Hydrograph	F2	F2	F2	F2
Impervious Surface	P2	F2	G2	F2
Stream Corridor				
Riparian Vegetation	P2	F2	F2	F2
Stream Bank Stability	F2	F2	P1	G2
Floodplain Connectivity	P2	F2	P2	F2

Support for Limiting Habitat Factor Rankings in the Bonaparte Creek Sub-watershed

Reach 1-

Water Quality

Data was collected in the same time period for dissolved oxygen, temperature, turbidity, and nutrient information.

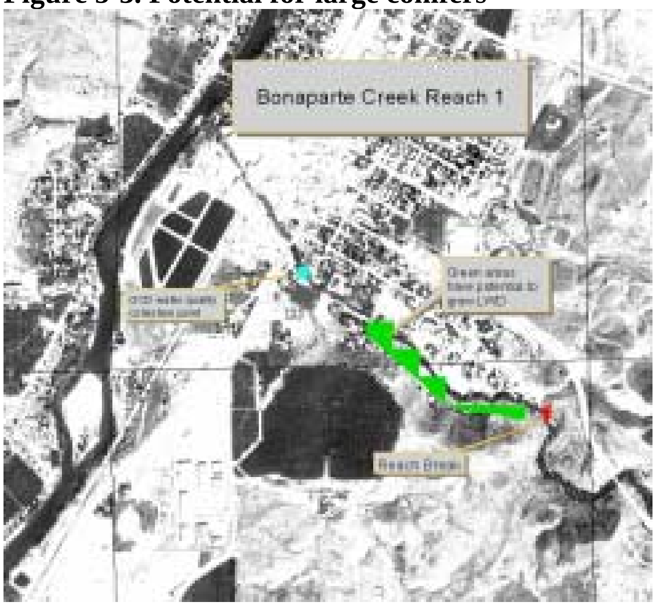
1) Dissolved Oxygen - Dissolved oxygen is rated Good based on greater than 95% saturation levels as represented in data collected by the Okanogan Conservation District (OCD) spot checks in 2000.
2) Stream Temperature.- Stream temperatures were below 18°C with a maximum temperature of 15.5°C recorded on 7/12/2000.
3) Turbidity - Turbidity measurements were all less that 100 NTUs. Two ratings greater than 20 NTUs on 5/10/2000 and 6/14/2000 were recorded. The maximum was 35.7 NTUs. This reach is rated fair for turbidity.
4) Nutrient Loading - Chemical Contamination/Nutrient Loading for dissolved nitrates, nitrites, Fecal coliform, phosphates and calcium carbonate and bicarbonate were recorded by OCD in 2000.

In-Channel Habitat

Fine Sediment - The substrate in the channel on the private lands has not been extensively observed, but while fishing in the Okanogan River at the confluence and while walking up the street along Bonaparte Creek I have noticed large amounts of fine substrate. The creek runs brown with silts and sands regularly in spring and on occasion in the summer and fall.

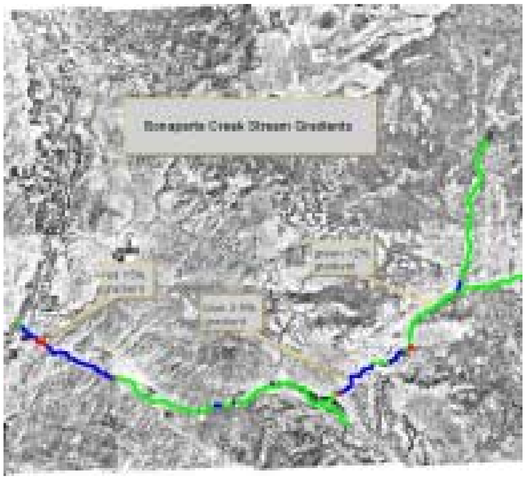
Large Woody Debris - Sites with potential for providing large woody debris (LWD) are depicted on **Figure 5-3**. Non-forested habitat types, shrub steppe, and/or rock comprise 83% of 50 meter wide buffers on each side of Bonaparte Creek. Conifer trees of a size to be classified as LWD, 35 feet long with a diameter of 12 inch, are not likely to grow in these non-forested habitat types. Bonaparte Creek is not large enough to transfer LWD downstream to this reach. The potential for large woody debris recruitment is lower naturally in this reach because of this. By the matrix definitions, this reach rates poor for large woody debris.

Figure 5-3. Potential for large conifers



Percent Pools - **Figure 5-4** depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total stream length in this Reach is 1.0 mile. The amount of stream channel that has 2% or less gradient is .15 miles (15% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is .85 miles (85% of the channel length in this reach). None of stream channel is greater than 5% gradient in this reach. Remote sensing using a 10-meter digital elevation models was used to make these determinations. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The numbers of pools in this reach are few; the actual number of pools in this reach is a Data Gap.

Figure 5-4. Stream Channel Gradients



Habitat Access
This criterion rated fair because two culverts are velocity barriers at times, and the channel itself, in areas, is a velocity barrier. Bonaparte Creek has been confined to a channeled trench through the town of Tonasket.

Stream Flow
Resembles Natural Hydrograph - The stream flow in Reach 1 is altered as a result of water withdrawals upstream in most years. The channel alterations upstream have changed timing of runoffs reducing summer thermal refuge at the confluence with the Okanogan River for steelhead smolt and adult sockeye salmon.

Impervious Surfaces - City streets and large parking lots along this reach of Bonaparte Creek create quick runoff and little interaction with the floodplain. This parameter has been rated poor.

Stream Corridor
Riparian Vegetation - The riparian vegetation in this reach rated poor, based on spot visual observations by myself. Shade has been greatly reduced in the lower portion of Reach 1; homes and lawns, and parking lots have replaced the natural vegetation. Trees and other vegetation have also been removed for clearing of the road right-of-ways.

Stream Bank Stability - Little or no channel bank erosion occurs in this reach. Stream bank stability is rated fair because stability of the channel is not maintained by vegetation. The stream bank is maintained in a stable condition with rip-rap through the city of Tonasket.

Floodplain Connectivity - Flood plain connectivity is rated as poor based on spot visual observations. Bonaparte Creek has been channeled through the city of Tonasket.

Reach 2-

Reach 2 affects the water quality downstream in Reach 1, but due to its steep gradient and an impassible barrier at the beginning, Reach 1 is not considered anadromous fish habitat.

Water Quality
No data was collected for dissolved oxygen, temperature, turbidity, and nutrient information in this reach. Best guesses are made on personal observations.

Dissolved Oxygen - Dissolved oxygen (DO) data was not collected, but the average channel gradient is greater than 3% in this reach and there are 3 waterfalls greater than 10 feet high. Sufficient mixing occurs in this reach to saturate DO levels in the water, and a rating of good is my determination.

Stream Temperature - No data for stream temperature is available in this reach. In the Limiting Factors Table DO for Reach 3 is a Data Gap (DG). Temperatures taken downstream rated good. This area is a deep canyon and the stream is shaded much of the day from brush small trees and the canyon walls itself. Stream temperatures taken downstream in Reach 1 and upstream in Reach 4 rated good. It is unlikely that stream temperatures rise above 18°C in this reach and a rating of good is suggested.

Turbidity - No data for turbidity is available in this reach. It is likely in poor condition in years that have normal rainfall conditions, and fair condition in years with lesser rainfall or slow snowmelt.

Nutrient Loading - No data for nutrient loading and chemical contamination information is available in this reach. A few homes and State Highway 20 are the only developments along the stream in this reach. Runoff from State Highway 20 leads directly to the stream in this reach, and if any spills were to occur on the road the material would enter the water. This parameter is a Data Gap.

In-Channel Habitat

Substrate - Because Reach 2 is not considered to provide anadromous fish habitat, the substrate condition criterion does not apply to spawning substrate. This reach does contain fine sediment and it is transported to the fisheries below. Sanding of State Highway 20 in this reach adds to the amount of fine sediment delivered to the fisheries below.

Large Wood - Using a Plant Association Group cover generated for use by the U.S. Forest Service, determination of suitable habitat for conifer growth was made. In Reach 2 non-forested habitat types, rock mainly, comprise 23% of 50-meter wide buffers on each side of Bonaparte Creek. There is a Data Gap regarding the number of pieces of large woody debris within this reach.

Percent Pools - Figure 2 depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total stream length in this Reach is 3.8 miles. None of stream channel gradient is 2% or less in this reach. The amount of stream channel that is of 2-5 % gradient is 2.9 miles (76% of the channel length in this reach). The amount of stream channel that is greater than 5% gradient is 0.9 miles (24% of this reach). Remote sensing using a 10-meter digital elevation models was used to make these determinations. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The numbers of pools in this reach are few; the actual number of pools in this reach is a Data Gap.

Habitat Access

Fish Passage - This criterion is not applicable. Anadromous fish habitat ends at the waterfall at the beginning of the reach.

Stream Flow

Resembles Natural Hydrograph - Stream flow information was not collected in this reach. Flows in this reach and the other reaches were determined to be in fair condition using the criteria that flow timing and amount are altered but not drastically so.

Impervious Surfaces - State Highway 20 along this Reach is the largest unnatural impervious surfaces. The length and proximity of the road was used to determine a ranking of fair.

Stream Corridor

Riparian Vegetation - The vegetation has been altered, but still appears to be within 25-50% of the potential natural community composition. The vegetation composition of this Reach is rated as fair.

Stream Bank Stability - Bonaparte Creek is well shaded in this reach and banks are held stable from deciduous vegetation in most locations. Other locations are held stable from rip-rap. Driving State Highway 20,one sloughing area is noticeable. Bank stability is rated fair for this reach.

Floodplain Connectivity - The construction and maintenance of the State Highway 20 has altered the sideslopes and narrowed the floodplain in places. In places where the sideslopes are quite steep, the floodplain and the road share limited space. This criterion is considered as fair.

Reach 3-

Water Quality

Reach 3 affects the water quality downstream in Reach 1. Although the gradient in much of the reach is less than 2%, the water in the stream interacts with the floodplain in few locations. The channel is confined to a narrow 10 foot deep cut through sandy-loam from river mile 5.1 to 6.3. From river mile 6.3 to 10.8 the channel is downcut but to a smaller degree. Due to its steep gradient and an impassible barrier at the beginning of Reach 2, Reach 3 is not considered anadromous fish habitat. Reach 3 water quality parameters of; stream temperature, turbidity and nutrient loading have the potential to affect the anadromous fisheries downstream in Bonaparte Creek and in the Okanogan River. No data was collected for dissolved oxygen, temperature, turbidity, and nutrient information in this reach. Best guesses are made on personal observations.

Dissolved Oxygen - Dissolved oxygen (DO) data was not collected. The average channel gradient is near 2% in this reach. In the Limiting Factors Table DO for Reach 3 is a Data Gap (DG). It is likely that insufficient mixing occurs to saturate DO levels in the water. A rating of fair is suggested.

Stream Temperature - No data for stream temperature is available in this reach. In the Limiting Factors Table DO for Reach 3 is a Data Gap (DG). This area is a deep canyon and the stream is shaded much of the day from brush small trees and the canyon walls itself. Stream temperatures taken downstream in Reach 1 and upstream in Reach 4 rated good. It is unlikely that stream temperatures rise above 18°C in this reach and a rating of good is suggested.

Turbidity - No data for turbidity is available in this reach. In the Limiting Factors Table DO for Reach 3 is a Data Gap (DG). The stream flows through a downcut trench from river mile 5.1 to 6.3. The channel upper channel banks range from 6 to 12 feet tall through this portion of the reach. In many areas these banks are not stable, more than 20% unstable total. Turbidity rating is likely in poor condition in years that have normal rainfall and snow conditions, and fair condition in years with lesser rainfall or slow snowmelt. In the Limiting Factors Table DO for Reach 3 is a Data Gap (DG).

Nutrient Loading - No data for nutrient loading and chemical contamination information is available in this reach. A few homes and State Highway 20, hay fields and some livestock yards are the identified developments along the stream in this reach. In the Limiting Factors Table DO for Reach 3 is a Data Gap (DG). No suggestion is made in this reach for this parameter.

In-Channel Habitat

Substrate - Because Reach 3 is not considered to provide anadromous fish habitat, the substrate condition criterion does not apply to spawning substrate. This reach does contain and generate fine sediment. It is transported to the fisheries below. The eroding channel throughout the reach adds to the amount of fine sediment delivered to the fisheries below. Large amounts of fine sediment are produced downstream of the last functioning depositional area (river mile 10.8). A large area beginning at river mile 5.1 and continuing for more than a 5 miles upstream is down cutting, and has created tall vertical banks confining the stream to a trench. The most significant example of this is located within a riparian enclosure approximately at river mile 5.1 to 6.3. This area was identified by the OCCD for project work to reduce sediment delivery to the Okanogan River in 1987. Here the stream still has 10-foot tall bare vertical upper banks. Sediment generating from this portion of the stream is carried to anadromous fishes redds below.

Large Wood - Using a Plant Association Group cover generated for use by the U.S. Forest Service, determination of suitable habitat for conifer growth was made. In Reach 2 non-forested habitat types, shrub steppe, comprise 48% of 50-meter wide buffers on each side of Bonaparte Creek. Much of the reach can be seen from State Highway 20. No pieces of wood seen in Bonaparte Creek in this reach meet the criteria and a rating of poor is given. Large woody debris that may fall into the channel upstream of the wet meadow (river mile 10.8) is not likely to be delivered downstream to other reaches.

Percent Pools - Figure 2 depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total stream length in this Reach is 6 miles. The amount of stream channel gradient is 2% or less is 5.3 miles (89% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is .7 miles (11% of the channel length in this reach). None of stream channel that is greater than 5% gradient in this reach. Remote sensing using a 10-meter digital elevation models was used to make these determinations. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The numbers of pools and amount of pool habitat is a Data Gap.

Habitat Access

Fish Passage - This criterion is not applicable. Anadromous fish habitat ends at the waterfall at the beginning of the Reach 2.

Stream Flow

Resembles Natural Hydrograph - Stream flow information was not collected in this reach. Flows in this reach and the other reaches were determined to be in fair condition using the criteria that flow timing and amount are altered but not drastically so.

Impervious Surfaces - State Highway 20 along this Reach is the largest unnatural impervious surface. Runoff and ditching is not extensive even though State Highway is very near Bonaparte Creek. This parameter deserves a ranking of good.

Stream Corridor

Riparian Vegetation - Riparian vegetation is in fair to poor condition (Tonasket Ranger District 1996), with the potential natural community and composition being at or near 20%. State Highway 20, agriculture, housing, and livestock grazing pastures all have contributed to the alterations of vegetation along the stream in this reach.

Stream Bank Stability - Stream bank stability is in poor condition. From 1988 OCCD survey information and personal experience. The 1988 survey listed 1.5 miles of the riparian as having severe erosion. Restoration efforts by the Okanogan County Conservation District in 1989 built a riparian enclosure fence. Since then alder and dogwood has vegetated the area. Bare vertical banks still exist in much of the area. “Problem” beaver have been removed while trying to recolonize this area (D. Swedberg, personal communication, 2001). Moderate erosion was noted in 8 areas, totaling 1.6 miles of this reach. One mile of moderate erosion from grazing impacts was identified. It was noted that improvement in the riparian habitat in 4 of these areas, nearly 1 mile of stream, would improve water quality.

Floodplain Connectivity - The floodplain connectivity is currently in poor condition from the lack of stream water interaction due to the downcutting that has and still occurs in this reach.

Reach 4-

Water Quality-

Dissolved Oxygen (DO)-: Stream Temperature-: Turbidity-: Nutrient Loading-

Reach 4 includes Bonaparte Creek and it tributaries upstream of a braided channel woodland in T39N, R28E, Section 23, NE 1/4. The braided channel area intercepts much of the sediment that might be delivered, the DO and temperature and nutrient loading are altered as a result of the transport through the 6 miles of Reach 3 and the 3.8 miles of Reach 2. Water quality parameters; DO, temperature, turbidity and nutrient loading, of Reach 1 is not affected to a discernable degree by the relatively small amount of pollutants in generated in Reach 4. These criteria are not applicable, and are not discussed here. The Limiting Factors Table for reach 4 is populated with the data supplied by the OCD. The water collection area for the OCD data is upstream of the Aeneas Valley road on Bonaparte Creek.

In-Channel Habitat

Fine Sediment - Little fine sediment from this reach is delivered to the spawning area in Reach 1. Fine sediment falls out of solution in the spread channel wetland river mile 10.8 to 11.4. Sand from road maintenance in winter along State Highway 20 directly enters the stream in at least .8 miles of this reach. This material likely drops out of the water column at or before river mile 10.8.

Large Wood - Sites with potential for providing large woody debris (LWD) were not done for Reach 4. Conifer trees of a size to be classified as LWD, 35 feet long with a diameter of 12 inch, are likely to grow along Bonaparte Creek, but the creek is not large enough to transfer LWD downstream to other reaches. The amount of LWD in Reach 4 is a Data Gap.

Percent Pools - Figure 2 depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total length of streams in this reach is 21.9 miles. The amount of stream channel gradient is 2% or less is miles (83% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is 3.1 miles (14% of the channel length in this reach). The amount of stream channel that is greater than 5% gradient is .6 miles (3% of the channel length in this reach). Remote sensing using a 10-meter digital elevation models was used to make these determinations. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The numbers of pools and amount of pool habitat is a Data Gap.

Habitat Access

Fish Passage - This criterion is not applicable. Anadromous fish habitat ends at the waterfall at the beginning of the Reach 2.

Stream Flow

Resembles Natural Hydrograph - Flows in this reach and the other reaches were determined to be in fair condition using the criteria that flow timing and amount are altered but not drastically so. The Bonaparte Water Users Association has water right to 1080 acre-feet of water from Bonaparte Lake. (An unpublished memorandum, USFS, 1967).

Impervious Surfaces - State Highway 20 along this Reach is the largest unnatural impervious surface. Runoff and ditching is not extensive, but one area along State Highway is adjacent to Bonaparte for .8 miles. This area has direct runoff to the creek, for this reason; this parameter deserves a ranking of fair.

Stream Corridor

Riparian Vegetation - Maintenance of State Highway 20 right of way, agricultural development and livestock grazing have altered the riparian vegetation in this reach, but still appears to be within 25-50% of the potential natural community composition. The vegetation composition of this Reach is rated as fair.

Stream Bank Stability - Stream bank stability is in good condition. The survey by OCCD in 1988 identified 1.5 miles of heavy grazing on 12.8 mile of stream surveyed. It is unknown if these areas have been restored to a better condition. From observations along State Highway 20 this area has sufficient vegetation to stabilize the stream banks where State Highway 20 is adjacent to Bonaparte Creek and vegetation is lacking the channel is stabilized with rip-rap.

Floodplain Connectivity - The floodplain connectivity is currently in fair condition. Several large areas in this reach have downcutt or straightened channels. Bonaparte Meadows, just below Bonaparte Lake, have been and currently are being mined for peat. This area still becomes saturated with water. Other areas where channel alterations are evident occur in hay fields near the confluence with Peony Creek and upstream of the County Road 4953, Bonaparte Lake road, on a tributary to Bonaparte Creek. State Highway 20 in areas has also reduced the streams coconnectedness to the floodplain. These areas have reduced the creeks interaction with the floodplain, and overbank flows are reduced but are still present in this reach, that is the reason for the fair rating.

Sub-watershed Overview

The Siwash Watershed is 30,946 acres. Of these acres, 10,567 (34%) acres are managed by the USFS, the remaining 20,379 (66%) acres are a combination of ownership that includes private owners (60%), Washington Department of Natural Resources (5.5%), and Bureau of Land Management managed lands (<1%).

Land Use and Ownership

Private lands adjacent to Siwash Creek are used primarily as rangelands, agriculture, and home sites. Primary use of USFS, DNR and BLM lands are timber production and/or livestock allotments.

Topography, Geology & Soils

Tonasket, Antoine, Siwash and Bonaparte watersheds are all part of the Okanogan sub-continent (Alt and Hyndman 1984). The eastern and southern boundaries are formed by the Columbia River. The western boundary, the Okanogan River valley, is geologically known as the Okanogan trench. The Okanogan sub-continent extends hundreds of miles north into British Columbia, Canada.

The Okanogan sub-continent was an island about the size of California that crashed into the Kootenay Arc (which was then the western edge of the continent), about 100 million years ago. Following this "docking" of the sub-continent came the filling of what was then the "coastal area" on the west edge of the Okanogan sub-continent, the Okanogan trench (now the Okanogan Valley) (Alt and Hyndman 1984). The intersection of these two geologic features (the Okanogan sub-continent and the Okanogan trench) appears to be where barriers of waterfalls or high gradient stream channels occur. These barriers preclude upstream migration of anadromous salmonids.

The elevation of the confluence of Siwash Creek with the Okanogan River is 880 feet. The highest point in the Siwash Creek watershed is Fourth of July Ridge on Bonaparte Mountain at 6720 feet. The Siwash Watershed is oriented on an east to west axis.

Tectonic uplifting: continental glaciations, and volcanic ash deposition all played major roles in shaping the existing topography and soils characteristics of this watershed.

Continental glaciations have had the greatest impact. Large areas of exposed rock and shallow soils were left as a result of the flow and retreat of the Okanogan and Sanpoil lobes of this cordilleran ice sheet. Bedrock is overlain by Quaternary glacial till outwash and glaciolacustrine sedimentary deposits of varying thickness.

The upper elevation bedrock is tertiary medium to coarse grain grandiorite and granite of the Mt. Bonaparte pluton.

The lower elevations are underlain with pre-tertiary banded gneiss and schist of the Tonasket gneiss. Both rock types are included in a metamorphosed and structural uplift called the Okanogan gneiss dome (USFS 1998 and 1999).

Riparian Vegetation and In-channel Habitat

Streamside vegetation has been altered greatly in the reaches where land uses are agricultural, and pastureland in the upper portion. Home sites, and commercial uses in the Tonasket area have altered the lowest reach.

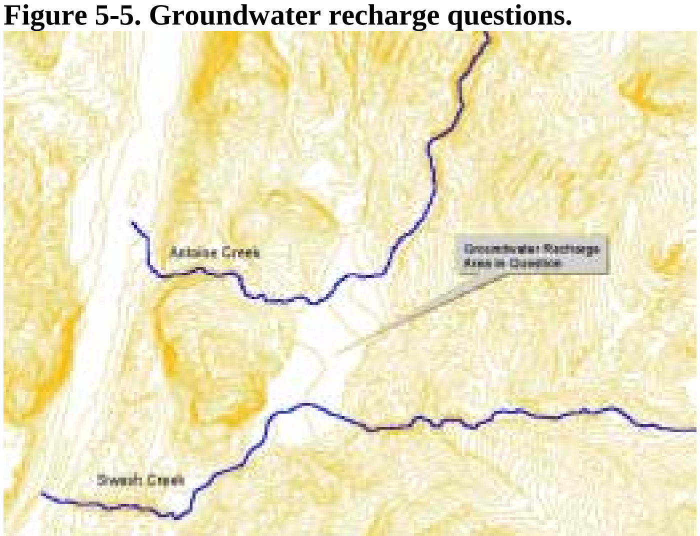
In-channel large woody debris appears to be lacking in much of Siwash Creek. Non-forested habitat types, shrub steppe, occur frequently along Siwash Creek. It is unlikely large woody debris recruitment would occur from those sites.

Water Quantity/Hydrology

Water Quantity is the main limiting factor associated with Siwash Creek Watershed. Data from the downstream OCD site show that Siwash Creek was completely dry from July 10, 2000 through November 30, 2000.

Irrigation withdrawals peak at this time and may be the reason for such reduced surface flows. Another hypothesis is that Siwash Creek recharges groundwater draining to Antoine Creek, and Siwash Creek will only have surface flows during times when the groundwater "aquifer" is sufficiently recharged to spill water into the Siwash rivulet (**Figure 5-5**). This data gap should be resolved before attempts of summer and fall flow predications in the downstream reach of Siwash Creek are made.

Figure 5-5. Groundwater recharge questions.



The following is from the Tonasket Watershed Assessment (USFS 1998) hydrology section and applies to Siwash Creek watershed: Tonasket Creek watershed is characterized by high spring runoff due to melting snowpack that accumulates in late fall and the winter months. Summer and fall runoff is low, fed by the release of stored water from riparian areas in floodplains, seeps, and springs at the headwater tributary streams.

Stream flow timing has changed through channel alterations in headwater tributary streams and on Siwash Creek. These alterations have cut the channels deeper resulting in reduced ground water recharge to a small extent in this watershed.

The road network has influenced the timing of run-off. Several roads intercept ground water and re-routes the water overland through ditches. This interception reduces the amount of late season flow by routing water from storm and melt water directly to stream channels. Using the USFS existing road layer, twenty-eight miles of road (24% of roads in watershed) were found to be within 100 meters of the seventy-six miles of streams. Surface water also reaches these road drainage ways and leaves more quickly than if it were to recharge ground water storage areas.

Although channel alterations have altered the drainage of surface water in the Siwash Creek Watershed, a large agricultural complex functions, during spring runoff, to slow water velocities and allow for groundwater recharge. Road network effects downstream of this recharge area seen but to a much smaller extent.

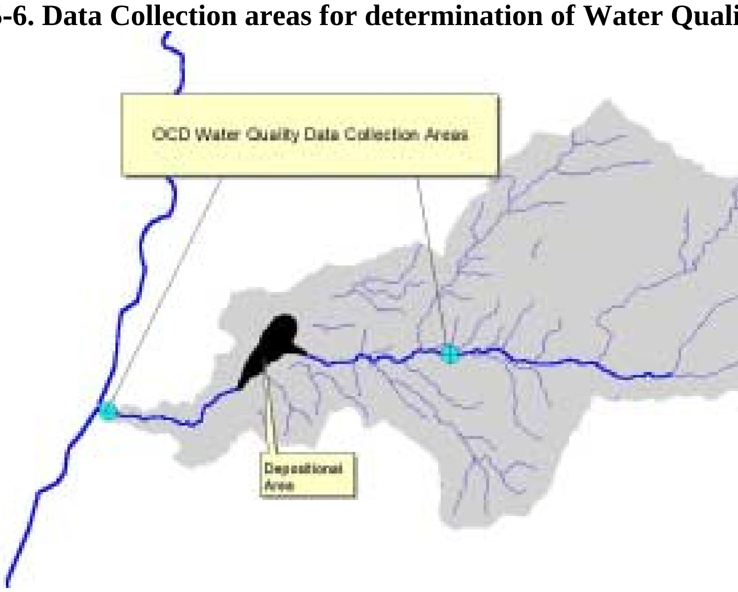
Irrigation withdrawals from the creek are made from Siwash Creek and its tributaries. Uses of water from withdrawals are irrigation of fields, stock watering and household water. One withdrawal from Siwash Creek and one withdrawal from North Fork Siwash are documented on the Washington State Department of Ecology's Water Rights Tracking web page http://www.ecy.wa.gov/programs/wr/info/wrats/Wria-ok.htm.

Water Quality

Channel alterations have altered the drainage of surface water in the Siwash Creek Watershed to a small extent. An agricultural area located in Township 37 Range 27 section 12, functions during spring runoff to slow water velocities and allow for groundwater recharge.

OCD has data for water quality at two locations on Siwash Creek (**Figure 5-6**). There was no water in the channel from July to November at the downstream location. In Reach 1, a turbidity value of 6.84 NTU (good rating) was recorded on June 12, 2000. On the same day in Reach 3 the turbidity value was over 160.00 NTU (poor rating).

Figure 5-6. Data Collection areas for determination of Water Quality on Siwash Creek.



Areas upstream of this agricultural area in Township 37 Range 27 section 12 will have no influence on the water quality parameters of dissolved oxygen, nutrient loading, pH, and turbidity within the historical range of anadromous fishes on Siwash Creek or the Okanogan River. Late summer and fall flows from Siwash Creek could effect the stream temperatures and create summer thermal refuge in the Okanogan River at the confluence with Siwash Creek and immediately downstream.

Water quality conditions in Siwash Creek, downstream from the groundwater recharge/depositional area changes as it flows downstream. Trout are found in the creek immediately downstream of this area, suggesting that water is present year around at this location. Downstream from this point Siwash Creek flows through deeply incised glacial till deposits.

Direct road runoff from Count Road 9467 is likely but for only a short distance and is not likely to alter water quality conditions with exceptions, (i.e. resurfacing, transport spills) Runoff from the USFS parking lot enters Siwash Creek. Several home sites are adjacent to the stream and it is likely that septic systems drain to the creek. Agricultural lands are located on lands up to the break in slope along much of Siwash Creek, and runoff from these orchards and fields is likely to enter Siwash Creek. All have potential to affects water quality of Siwash Creek.

Siwash Creek is not on the Washington State List of Threatened and Imperiled Waterbodies (the 303d list).

Anadromous Salmonid Fisheries Resources of Siwash Creek

Anadromous fisheries resources are restricted to the lower 1.4 miles of the Siwash Creek sub-watershed due to an impassible steep gradient channel (**Figure B-15**). Suitable spawning habitat occurs in Siwash Creek only when flows are sufficient to allow migration upstream.

Steelhead

No data is available about the use of Siwash Creek for rearing or spawning of Upper Columbia River Summer Steelhead. It is assumed that passage of adults is not restricted up to river mile 1.4, to the steep gradient channel area. Juvenile fish, either resident rainbow trout or steelhead do invade the lower reaches in the spring.

Chinook Salmon

Summer/fall chinook salmon are known to use the mainstem Okanogan River as well as the Similkameen River to Enloe Falls. . The mainstem Okanogan River is used for migration northward to Canadian waters. Most of the known summer/fall chinook spawning areas are in the Similkameen River. Chinook salmon do not use Siwash Creek for spawning, and juvenile use is a data gap.

Spring Chinook Salmon

Adult spring chinook salmon (*Oncorhynchus tshawytscha*) in the Upper Columbia Basin are not currently known to use the Okanogan River. The temperature regime at the time spring chinook salmon spawn in the mainstem Okanogan River is too high for successful spawning and rearing. Water temperatures are elevated due to irrigation water withdrawals (K. Williams and J. Spotts, personal communications). In their Endangered Status of One Chinook Salmon ESU Final Rule (U.S. Federal Register 1999), the National Marine Fisheries Service excluded the Okanogan River from their Endangered species listing for the Upper Columbia Evolutionarily Significant Unit (ESU) of spring chinook salmon. The Okanogan River was excluded from the listing because spring chinook adults are collected as they migrate upstream at Wells Dam on the Columbia River, approximately 20 miles downstream of the confluence of the Okanogan River. The adult salmon are transported to the Winthrop National Hatchery in Winthrop, Washington, and are spawned there. The eggs and resulting fry are raised at the hatchery and later released into the Methow River.

Sockeye salmon

Sockeye salmon are known to use the mainstem Okanogan River as a migration pathway to their spawning areas in Lake Osoyoos and the upstream reaches of the Canadian Okanogan River. Sockeye salmon adults do not use Siwash Creek, and juvenile use is a data gap.

Bull trout

There are no data or anecdotal information indicating bull trout ever were, or that bull trout currently are, in the Siwash Creek watershed. Data that does exist suggests that bull trout did not exploit the Okanogan River north of the city of Omak, approximately 30 river miles down-river of the confluence of Siwash Creek with the Okanogan River (K. Williams, personal communication). The Okanogan River is not suitable habitat for bull trout due to the bull trout requirement of very cold, clean waters with clean gravel/cobble substrate for successful spawning and rearing.

Scott and Crossman (1973) reported that bull trout are not present within the Canadian Okanogan River system.

Limiting Factors Assessment

Siwash Creek was divided into three reporting units (reaches) addressing potential limiting factors to salmonid production in Siwash Creek and in the Okanogan River.

Reach 1 (from the mouth of Siwash Creek to River Mile 1.4) is considered usable anadromous salmonid habitat provided that there is adequate flow. Reach 1 ends at a natural channel gradient break. The channel gradient is 14%, and most likely the extent of adult and juvenile fish.

Reach 2 (River Mile 1.4 to RM 4.4) includes the steep gradient channel. This reach ends at County Road 9467 bridge upstream of the depositional area. This reach has potential to affect water quality to the anadromous fishery, but is not considered to be usable habitat for anadromous fish because of the natural barriers.

Reach 3 (River Mile 4.4 and above) Water quantity, timing and amount, is important factors to track in this reach.

The following rankings reference habitat criteria accepted by the Okanogan TAG group as most relevant to the production potential of anadromous salmonid fishes in the Okanogan (**Table 5-17**).

Table 5-17: Siwash Creek Limiting Factors Assessment

Attribute Considered	Anadromous potential, Water Quality concerns
Water Quality	
Dissolved Oxygen	
Stream Temperature	
Turbidity/Suspended Sediment	
Nutrient Loading	
In Channel Habitat	
Fine Sediment (substrate)	
Large Woody Debris	
Percent Pool	
< 2%	
2-5%	

Attribute Considered	Anadromous potential, Water Quality concerns
>5%	
Habitat Access	
Fish Passage	
Stream Flow	
Resembles Natural Hydrograph	
Impervious Surface	
Stream Corridor	
Riparian Vegetation	
Stream Bank Stability	
Floodplain Connectivity	

Support for Limiting Habitat Factor Rankings in the Siwash Creek Sub-watershed

Reach 1-
Water Quality

Data was collected in the same time period for dissolved oxygen, temperature, turbidity, and nutrient information (**Figure 5-7**).

Figure 5-7. OCD water quality data collection location in Reach 1.

Dissolved Oxygen - Dissolved oxygen is rated Good based on greater than 95% saturation levels as represented in data collected by the Okanogan Conservation District (OCD) spot checks in 2000.
Stream Temperature - Stream temperatures were below 18°C with a maximum temperature of 15.3°C recorded on 5/18/2000.

Turbidity - Turbidity measurements were all less that 100 NTUs. Two ratings both less than 20 NTUs on 5/18/2000 and 6/12/2000 were recorded. The maximum was 6.84 NTUs. This reach is rated good for turbidity.

Nutrient Loading - No data for Chemical Contamination/Nutrient Loading for dissolved nitrates, nitrites, Fecal coliform, phosphates and calcium carbonate and bicarbonate were recorded by OCD in 2000 and is listed in the table as a Data Gap (DG).

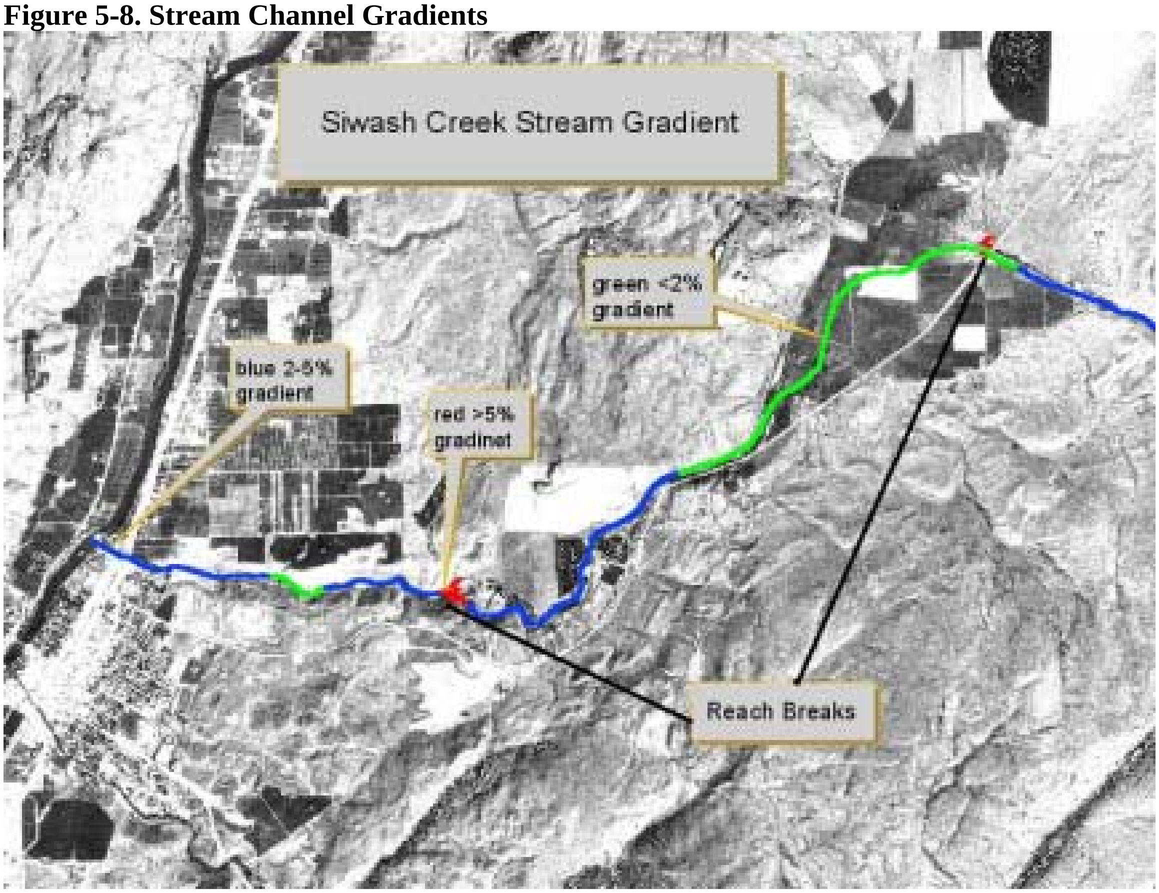
In-Channel Habitat

Fine Sediment - The substrate in the channel on the private lands has not been extensively observed, but while fishing in the Okanogan River at the confluence and while walking along Siwash Creek at the Tonasket Ranger District, I have noticed some sand and silt in the creek. The creek runs clear regularly in spring. A rating of fair for this category was given because 12-20% of the streambed composition is smaller than 0.85mm in likely spawning locations.

Large Woody Debris - Non-forested habitat types, shrub steppe, and/or rock comprise 53% of 50 meter wide buffers on each side of Siwash Creek in this reach. Conifer trees of a size to be classified as LWD, 35 feet long with a diameter of 12 inch, are not likely to grow in these non-forested habitat types. Siwash Creek is not large enough to transfer LWD downstream to this reach. The potential for large woody debris recruitment is lower naturally in this reach because of this. The actual numbers of LWD is unknown. This reach rates poor for large woody debris using the matrix definitions.

Percent Pools - **Figure 5-8** depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total stream length in this Reach is 1.4 miles. The amount of stream channel that has 2% or less gradient is .2 miles (15% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is 1.2 miles (85% of the channel length in this reach). None of stream channel is greater than 5% gradient in this reach. Remote sensing using a 10-meter digital elevation models was used to make these determinations. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The number of pools in this reach is a Data Gap.

Figure 5-8. Stream Channel Gradients



Habitat Access

Fish Passage - Fish passage is assumed good. Siwash Creek has been confined to a channeled trench through the town of Tonasket, but the width of the trench allows for some sinuosity lowering velocities and allowing upstream movement by juvenile fishes. One stream crossing, identified on aerial photo, could pose a passage problem (**Figure 5-9**).

Figure 5-9. This area has not been visited, and is a Data Gap.

Stream Flow

Resembles Natural Hydrograph - The stream flow in Reach 1 is dewatered as a result of water withdrawals upstream in most years. Reduced summer thermal refuge at the confluence with the Okanogan River for steelhead smolt, adult chinook salmon, and adult sockeye salmon is a result.

Impervious Surfaces - City streets and large parking lots along this reach of Siwash Creek create quick runoff and little interaction with the floodplain. This parameter has been rated fair because of the relatively small amount of the reach in this condition.

Stream Corridor

Riparian Vegetation - The riparian vegetation in this reach rated fair, based on spot visual observations by myself. Shade has been reduced in the lower portion of Reach 1; homes and lawns, and parking lots have replaced the natural vegetation. The upper half has steeper banks and was not developed for home sites. Overall the reach has moderate loss of connectivity, and moderate loss of shade.

Stream Bank Stability - Little or no channel bank erosion occurs in this reach. Stream bank stability is rated fair because stability of the channel is not maintained by vegetation in many areas. The stream bank is maintained in a stable condition with rip-rap through the city of Tonasket.

Floodplain Connectivity - Flood plain connectivity is rated as poor based on spot visual observations. Siwash Creek has been channeled through the city of Tonasket, and vegetation succession has altered significantly.

Reach 2-

Reach 2 affects the water quality downstream in Reach 1, but due to its steep gradient and an impassible barrier at the beginning, Reach 2 is not considered anadromous fish habitat.

Water Quality

No data was collected for dissolved oxygen, temperature, turbidity, and nutrient information in this reach. No guesses are made because of the variety of uses and the lack of knowledge of water withdrawals.

Dissolved Oxygen - Dissolved oxygen (DO) data was not collected, and is listed as a Data Gap (DG).
Stream Temperature - Stream temperature data was not collected, and is listed as a Data Gap (DG).
Turbidity - Turbidity data was not collected, and is listed as a Data Gap (DG).
Nutrient Loading - Nutrient loading and chemical contamination data was not collected, and is listed as a Data Gap (DG).

In-Channel Habitat

Substrate - Because Reach 2 is not considered to provide anadromous fish habitat, the substrate condition criterion does not apply to spawning substrate. No data was not collected, and is listed as a Data Gap (DG).

Large Wood - Using a Plant Association Group cover generated for use by the U.S. Forest Service, determination of suitable habitat for conifer growth was made. In Reach 2 non-forested habitat types comprise 75% of 50-meter wide buffers on each side of Siwash Creek. There is a Data Gap regarding the number of pieces of large woody debris within this reach.

Percent Pools - Figure xxx depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total stream length in this Reach is 3.0 miles. The amount of stream channel that has 2% or less gradient is 1.7 miles (57% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is 1.2 miles (40% of the channel length in this reach). The amount of stream channel that is greater than 5% gradient is 0.1 miles (3% of this reach). Remote sensing using a 10-meter digital elevation models was used to make these determinations. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The numbers of pools in this reach is a Data Gap.

Habitat Access

Fish Passage - This criterion is not applicable. Anadromous fish habitat ends at the steep gradient channel at beginning of the Reach 2.

Stream Flow

Resembles Natural Hydrograph - Stream flow information was not collected in this reach, and is listed as a Data Gap (DG).

Impervious Surfaces - Little impervious surface was identified from the aerial photograph. This is rated to be in fair condition as some alteration was noticed.

Stream Corridor

Riparian Vegetation - The vegetation has been altered. Most notably the 300 acre depositional area has been converted to a series of hayfields with some natural vegetation occurring. The reach appears to be within 25-50%, likely 25%, of the potential natural community composition. The vegetation composition of this Reach is rated as fair.

Stream Bank Stability - Siwash Creek is well shaded in this reach and banks are held stable from deciduous vegetation in most locations. The depositional area is held stable from grasses and shrubs. At least 80% of the banks are stable and an argument that 90% of the banks are stable could be made. The bank stability is rated fair for this reach and could be rated good.

Floodplain Connectivity - Turbidity data in reach 3 upstream of the depositional area and the resulting data in Reach 1 is the best evidence that this floodplain remains connected, at least in part. The riparian vegetation succession does not occur here and for this reason this reach is considered as fair for this parameter.

Reach 3-

Water Quality-

The water flowing form Reach 3 does not affect the water quality in Reach 1. The timing of the water release in Reach 3 may have an effect on the water temperatures later in the year. The table is populated with water quality data from OCD but is not discussed for the reasons mentioned.

In-Channel Habitat

Substrate - Because Reach 3 is not considered to provide anadromous fish habitat, the substrate condition criterion does not apply to spawning substrate. This reach does contain and generate fine sediment. It is not transported to the fisheries below.

Large Wood - This parameter was not analyzed in this reach. No numbers of LWD are available for this reach. For these reasons this is a Data Gap (DG).

Percent Pools - This parameter was not analyzed in this reach. No numbers of pools or stream are available for this reach. For these reasons this is a Data Gap (DG).

Habitat Access

Fish Passage - This criterion is not applicable. Anadromous fish habitat ends at the steep gradient channel at beginning of the Reach 2.

Stream Flow

Resembles Natural Hydrograph - Flows in this reach were determined to be in fair condition using the criteria that flow timing and amount are altered but not drastically so.

Impervious Surfaces - For much of the length of the creeks in this reach gravel roads parallel the stream. For this reason a rating of fair is given for this parameter.

Stream Corridor

Riparian Vegetation - Riparian vegetation is in fair with the potential natural community and composition being at or near above 50% but, roads that parallel the streams creates in-complete protection of habitats and refugia for aquatic species.

Stream Bank Stability - Siwash Creek is well shaded in this reach and banks are held stable from deciduous vegetation in hotter dryer locations, and from conifers in forested environments. The roads have reduced the amount of floodplain that streams use in the lower elevations of this reach and undoubtedly erode during higher bankfull flows. 80% of the banks are stable in most years. The bank stability is rated fair for this reach.

Floodplain Connectivity - The floodplain connectivity is currently in poor condition from the lack of stream water interaction due to the downcutting that has and still occurs in this reach.

Reach 4-

Water Quality-

Dissolved Oxygen (DO)-: Stream Temperature-: Turbidity-: Nutrient Loading-
Reach 4 includes Siwash Creek and it tributaries upstream of a braided channel woodland in T39N, R28E, Section 23, NE 1/4. The braided channel area intercepts much of the sediment that might be delivered, the DO and temperature and nutrient loading are altered as a result of the transport through the 6 miles of Reach 3 and the 3.8 miles of Reach 2. Water quality parameters; DO, temperature, turbidity and nutrient loading, of Reach 1 is not affected to a discernable degree by the relatively small amount of pollutants in generated in Reach 4. These criteria are not applicable, and are not discussed here. The Limiting Factors Table for reach 4 is populated with the data supplied by the OCD. The water collection area for the OCD data is upstream of the Aeneas Valley road on Siwash Creek.

In-Channel Habitat

Fine Sediment - Little fine sediment from this reach is delivered to the spawning area in Reach 1. Fine sediment falls out of solution in the spread channel wetland river mile 10.8 to 11.4. Sand from road maintenance in winter along State Highway 20 directly enters the stream in at least .8 miles of this reach. This material likely drops out of the water column at or before river mile 10.8.

Large Wood - Sites with potential for providing large woody debris (LWD) were not done for Reach 4. Conifer trees of a size to be classified as LWD, 35 feet long with a diameter of 12 inch, are likely to grow along Siwash Creek, but the creek is not large enough to transfer LWD downstream to other reaches. The amount of LWD in Reach 4 is a Data Gap.

Percent Pools - Figure 2 depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total length of streams in this reach is 21.9 miles. The amount of stream channel gradient is 2% or less is miles (83% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is 3.1 miles (14% of the channel length in this reach). The amount of stream channel that is greater than 5% gradient is .6 miles (3% of the channel length in this reach). Remote sensing using a 10-meter digital elevation models was used to make these determinations. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The numbers of pools and amount of pool habitat is a Data Gap.

Habitat Access

Fish Passage - This criterion is not applicable. Anadromous fish habitat ends at the waterfall at the beginning of the Reach 2.

Stream Flow

Resembles Natural Hydrograph - Flows in this reach and the other reaches were determined to be in fair condition using the criteria that flow timing and amount are altered but not drastically so.

The Bonaparte Water Users Association has water right to 1080 acre-feet of water from Bonaparte Lake. (An unpublished memorandum, USFS, 1967).

Impervious Surfaces - State Highway 20 along this Reach is the largest unnatural impervious surface. Runoff and ditching is not extensive, but one area along State Highway is adjacent to Siwash for .8 miles. This area has direct runoff to the creek, for this reason; this parameter deserves a ranking of fair.

Stream Corridor

Riparian Vegetation - Maintenance of State Highway 20 right of way, agricultural development and livestock grazing have altered the riparian vegetation in this reach, but still appears to be within 25-50% of the potential natural community composition. The vegetation composition of this Reach is rated as fair.

Stream Bank Stability - Stream bank stability is in good condition. The survey by OCCD in 1988 identified 1.5 miles of heavy grazing on 12.8 mile of stream surveyed. It is unknown if these areas have been restored to a better condition. From observations along State Highway 20 this area has sufficient vegetation to stabilize the stream banks where State Highway 20 is adjacent to Siwash Creek and vegetation is lacking the channel is stabilized with rip-rap.

Floodplain Connectivity - The riparian vegetation succession does not occur where roads parallel the channel and for this reason the floodplain connectivity is currently in fair condition.

Antoine Creek Watershed Assessment

Sub-watershed Overview

The Antoine Creek watershed encompasses 46,695 acres of mixed ownership. The acres are a mixed ownership as follows: Private ownership, 30,000 acres (72%); Washington Department of Natural Resources, 2800 acres (6%); Bureau of Land Management managed lands, 459 acres (<1%); and the remaining 9,806 acres (21%) are managed by the US Forest Service (USFS).

Antoine Creek enters the Okanogan River 4 miles north of the city of Tonasket, Washington, at River Mile (RM) 61.2 of the Okanogan River. The watershed at its longest axis is approximately 14 miles long and its widest point is approximately 10 miles wide.

Antoine Creek is dammed at approximately RM 12 by Fancher Dam. Approximately 40% of the watershed acres drain to Antoine Creek above Fancher Dam, with the remaining 60% of the watershed draining to Antoine Creek below Fancher Dam. The Fancher Dam reservoir covers approximately 20 acres and is approximately 55 ft deep at its deepest point. The water stored in the Fancher Dam reservoir is used for irrigation of croplands.

Land Use and Ownership

Land within this watershed is predominantly in private ownership. Private lands adjacent to Antoine Creek are used primarily for agriculture (rangelands, hay fields, orchards), and for orcharding. Primary use of USFS, DNR and BLM lands are timber production and/or livestock allotments.

Roads parallel Antoine Creek (approximately 5 miles) and Whiskey Cache Creek (approximately 4 miles). There may be more roads adjacent to these streams. Available maps do not depict all the roads to residences in the area.

Fancher Dam is on private land and has been in place for almost 90 years. The reservoir behind the dam is used for private land irrigation purposes. Most of the water stored in the reservoir is used for irrigation of large hayfields. There is flow from the reservoir at spring run-off when the water level of the reservoir reaches and overtops the spillway.

There are other private land irrigation withdrawals made downstream of Fancher Dam. There is also a cement diversion structure at approximately RM 1 on Antoine Creek, on private land. The stream below this point is often dry or "near dry" in the summer and early fall months (D. Van Woert, personal communication).

There may also be some domestic use withdrawals from Antoine Creek.

Topography, Geology & Soils

Tonasket, Antoine, Siwash and Bonaparte watersheds are all part of the Okanogan sub-continent (Alt and Hyndman 1984). The eastern and southern boundaries are formed by the Columbia River. The western boundary, the Okanogan River valley, is geologically known as the Okanogan trench. The Okanogan sub-continent extends hundreds of miles north into British Columbia, Canada.

The Okanogan sub-continent was an island about the size of California that crashed into the Kootenay Arc (which was then the western edge of the continent), about 100 million years ago. Following this "docking" of the sub-continent came the filling of what was then the "coastal area" on the west edge of the Okanogan sub-continent, the Okanogan trench (now the Okanogan Valley) (Alt and Hyndman 1984). The intersection of these two geologic features (the Okanogan sub-continent and the Okanogan trench) appears to be where barriers of waterfalls or high gradient stream channels occur. These barriers preclude upstream migration of anadromous salmonids.

The elevation of the confluence of Tonasket Creek with the Okanogan River is 885 feet. The highest point in the Tonasket Creek watershed is Bonaparte Mountain at 7,258 feet. The Antoine Watershed is oriented on a northeast to southwest axis.

Tectonic uplifting, continental glaciation, and volcanic ash deposition all played major roles in shaping the existing topography and soils characteristics of this watershed. Continental glaciation has had the greatest impact. Large areas of exposed rock and shallow soils were left as a result of the flow and retreat of the Okanogan and Sanpoil lobes of the Cordilleran Icesheet. Bedrock is overlain by Quaternary glacial till outwash and glaciolacustrine sedimentary deposits of varying thickness.

The upper elevation bedrock is tertiary medium to coarse grain grandiorite and granite of the Mt. Bonaparte pluton.

The lower elevations are underlain with pre-tertiary banded gneiss and schist of the Tonasket gneiss. Both rock types are included in a metamorphosed and structural uplift called the Okanogan gneiss dome (USFS 1998 and 1999).

Vegetation and Riparian Condition

In-channel large woody debris appears to be lacking in much of Antoine Creek. Non-forested habitat types do occur along Antoine Creek and its tributaries, but the agricultural use of adjacent lands may preclude large woody debris recruitment to the stream. Shrub and forb vegetation are present along much of Antoine Creek, providing some bank stability and shade cover.

Water Quantity/Hydrology

Antoine Creek is characterized by high spring runoff from snowmelt (USFS 1999). Summer and fall runoff is low, fed by the release of stored water from riparian areas in floodplains, seeps, and springs at the headwater tributary streams. As indicated in USFS (1999), "the timing of some run-off has been influenced by the road network that intercepts ground water and re-routes it overland. Some of that surface water reaches drainage ways and leaves more quickly than ground water flow. The interception reduces the amount of late season flow".

Fancher Dam reservoir entrains water from both Antoine and Mill Creeks and their tributaries. The water in Fancher Dam reservoir is used for crop irrigation on Fancher Flats during the months of May to October, annually. During this time, flow at the mouth of Antoine Creek is minimal, and sometimes non-existent (D. Van Woert, personal communication). "Surface stream flows in the lowest reach of Antoine Creek is often reduced to no flow during the driest part of the year. Antoine Creek has sometimes been completely dewatered in dry years due primarily to irrigation withdrawals" (USFS 1999).

Other irrigation withdrawals occur downstream of Fancher Dam. Known withdrawal devices are at T38N, R28E, Section 31, SW$^1/_4$, NE $^1/_{16}$, and T38N, R27E, Section 35 NW$^1/_{4,}$ NW $^1/_{16.}$ The second withdrawal device may have an associated fish passage barrier. Water from Antoine Creek is also used in the early spring months for frost abatement on orchards (D. Van Woert, personal communication) Other withdrawals may also be occurring.

Water Quality

Antoine Creek is not on the Washington State List of Threatened and Imperiled Waterbodies (the 303d list). About 0.6 miles of stream channel in the Antoine Watershed are classified as sediment source reaches (USFS 1999). All of these sediment source reaches are upstream of functional depositional areas. A single sediment source reach approximately 0.40 miles long is situated upstream of Fancher Dam reservoir in an unnamed tributary to Antoine Creek. The remaining sediment source reaches (each about 0.05 miles long) are in unnamed tributaries to Antoine Creek and Whiskey Cache Creek. Whiskey Cache Creek, prior to its confluence with Antoine Creek (at approximately RM 4 of Antoine Creek) has a large wetland that filters sediment that might be delivered from upstream.

Anadromous Salmonid Fisheries Resources of Antoine Creek

Potential anadromous salmonid use of Antoine Creek is restricted to the lower 11.5 miles of the sub-watershed due waterfalls and a steep gradient channel that begins at RM 11.5 (**Figure B-16**). Steelhead adults are known to use the confluence area of Antoine Creek with the Okanogan River (C. Hinkley, personal communication). Sockeye and chinook salmon are not known to use Antoine Creek, but their use of the accessible habitat near the confluence for holding and limited rearing cannot be precluded. There are no data or anecdotal information indicating bull trout ever used the Antoine Creek watershed, likely because of inhospitable temperatures.

Rankings of Habitat Limiting Factors in the Antoine Sub-watershed

Antoine Creek was divided into three reporting units (reaches) to address potentially limiting factors to salmonid production for this document.

Reach 1 (from the mouth of Antoine Creek to River Mile 11.5) is considered usable salmonid habitat provided that there is adequate flow and the irrigation withdrawal structure is passable. Reach 1 ends at the base of a waterfalls that is considered to be a natural passage barrier.

Reach 2 (River Mile 11.5 to RM 12.0) includes the waterfalls and associated steep gradient channel. This reach ends at the base of Fancher Dam. This reach has an affect on downstream water quality, but is not considered to be usable habitat for anadromous fish.

Reach 3 (River Mile 12.0 and above) includes Fancher Dam reservoir and all of Antoine Creek and all its tributaries upstream of the reservoir. These places are inaccessible to fish moving upstream from the Okanogan River.

The following rankings reference habitat criteria accepted by the Okanogan TAG group as most relevant to the production potential of anadromous salmonid fishes in the Okanogan (**Table 5-18**).

Table 5-18. Antoine Creek Limiting Factors Assessment

Attribute Considered	Anadromous Potential Reach (RM 0 – 11.5)	Water Quality Reach (RM 11.5-12.0)	Non-Issue Reach (> RM 12.0)
Water Quality			
Dissolved Oxygen	F1	P1	N/A
Stream Temperature	G1	G1	N/A
Turbidity/Suspended Sediment	G1	G1	N/A
Nutrient Loading	DG	DG	DG
In Channel Habitat			
Fine Sediment (substrate)	F2	N/A	N/A
Large Woody Debris	P2	DG	N/A
Percent Pool	DG	N/A	N/A
Habitat Access			
Fish Passage	F2	N/A	N/A
Streamflow			
Resembles Natural Hydrograph	P1	P1	G2
Impervious Surface	G2	DG	G2
Stream Corridor			
Riparian Vegetation	F2	DG	G2
Streambank Stability	F2	G2	P2
Floodplain Connectivity	F2	G2	F2

Support for Limiting Habitat Factor Rankings in the Antoine Creek Sub-watershed

Reach 1-

Water Quality

Dissolved Oxygen - Dissolved oxygen is Fair based on the saturation level found during the summer months, as represented by data collected by the Okanogan Conservation District (OCD) from May 2000 to February 2001. Dissolved oxygen information is collected only when sufficient flowing water was present.

Stream Temperature - Stream temperatures were well below 18^{o} C., in the same time period as the DO information was collected.

Turbidity - Turbidity measurements were all less that 20 NTUs. Data was collected in the same time period as the dissolved oxygen information.

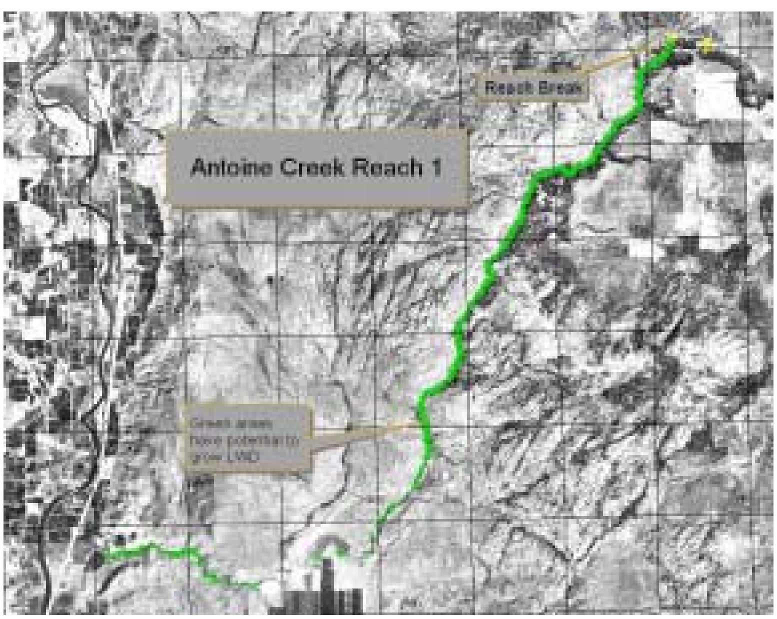
Nutrient Loading - A data gap exists for Chemical Contamination/Nutrient Loading.

In-Channel Habitat

Fine Sediment - The substrate in the channel on the private lands has not been extensively observed. Spot visual observations (K. Cooper, personal communication) at potential spawning sites reveal the substrate to be in a Fair condition.

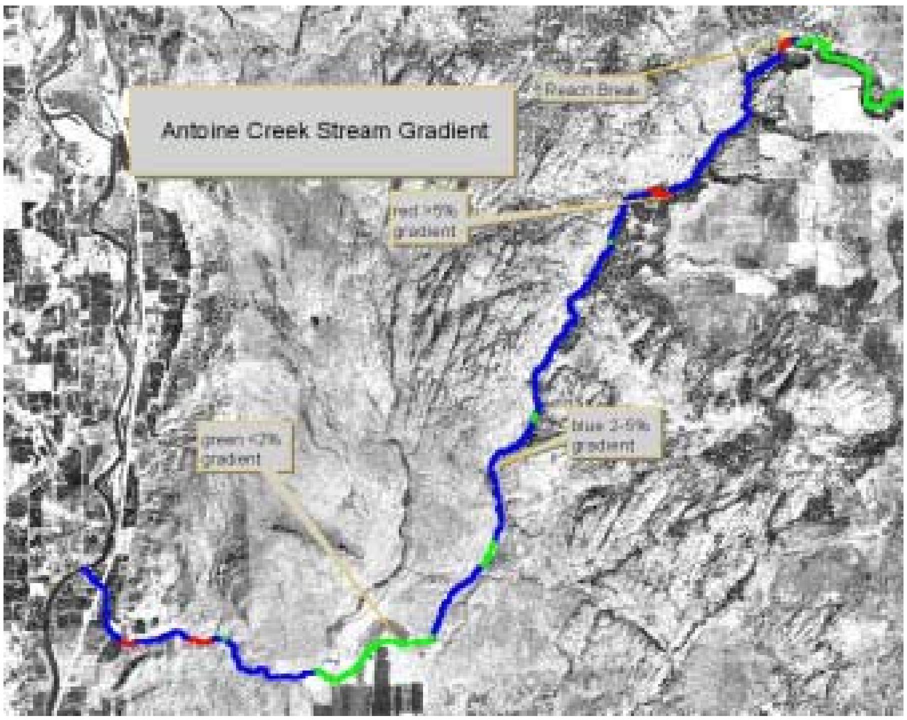
Large Woody Debris - Sites with potential for providing large woody debris (**Figure 5-10**). Determination was made by remote sensing (GIS/Arcview mapping), not from on-the-ground collected data. Non-forested habitat types comprise 37% of 50 meter wide buffers on each side of Antoine Creek. This indicates that the potential for large woody debris recruitment is low. By the matrix definitions, this reach rates Poor for large woody debris, but this rating must be tempered by considering the potential natural condition (non-forested) along this reach. Trees of a size to be classified as large woody debris are unlikely to grow in non-forested habitat types.

Figure 5-10. Potential for large conifers



Percent Pools - **Figure 5-11** depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total stream length in this Reach is 11.5 miles. The amount of stream channel that has 2% or less gradient is 1.6 miles (14% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is 8.8 miles (77% of the channel length in this reach). The amount of stream channel that is greater than 5% gradient is 1.0 miles (9% of the channel length in this reach). These determinations were made by remote sensing. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The actual number of pools in this reach is a Data Gap.

Figure 5-11. Stream Channel Gradients



Habitat Access

Fish passage is assumed beyond the two known irrigation diversions downstream of Fancher Dam. This is a Data Gap needing answered to fully appreciate available fish habitat in Antoine Creek. Because barriers are known to exist, but the extent of a barrier they present is not known, because the water levels in Reach 1 are known to fluctuate and at times to go dry, this criterion rated as Fair.

Stream Flow

Resembles Natural Hydrograph - The stream flow in Reach 1 is altered greatly by the operation of Fancher Dam for irrigation. In low water years, there is little, but more often no flow at the confluence of Antoine Creek with the Okanogan River (D. VanWoert, personal communication). This reach rates Poor for this criterion.

Stream Corridor

Riparian Vegetation - The riparian vegetation in this reach rated Fair, based on spot visual observations (K. Cooper, personal communication). Shade has been reduced in places due to agricultural conversion of lands to orchards, pastures, and crop lands, but the vegetative community appears to be within 25-50% of the potential natural vegetation.

Stream Bank Stability - Stream bank stability also seems Fair. Stability may have been modified by agricultural uses, either weakened by removal of vegetation, or perhaps reinforced by rip-rap.

Floodplain Connectivity - Flood plain connectivity is rated as Fair based on spot visual observations (K. Cooper, personal communication). Due to agricultural conversion of adjacent lands, the channel may be down-cutting somewhat.

The lowest portion of Antoine Creek was re-routed by Great Northern Railroad in the 1920s. The confluence was originally about ¼ mile south of where it is today (D. Van Woert, personal communication). Thus, the half mile of stream from the east side of Highway 97 to the confluence with the Okanogan River is a dug channel with no opportunity created for a flood plain. The exception is where the current Antoine Creek channel meets the floodplain of the Okanogan River, but it must be noted that the Okanogan River floodplain has also been influenced by the placement of the railroad line, Highway 97, and conversions of adjacent lands to agricultural use.

Reach 2-

Reach 2 affects the water quality downstream in Reach 1, but due to its steep gradient is not considered anadromous fish habitat.

Water Quality

Dissolved Oxygen - Dissolved oxygen, as shown in the OCD data for their sample site in Reach 2 indicates a saturation level of 60% (7.39 mg/l at 12.^{o} C., data collected from May of 2000 to February 2001). This gives this criterion a rating of Poor. However, the OCD collection site is above the waterfall. The waterfall mixes oxygen back into the water, as it continues downstream, raising the DO content as a result.

Stream Temperature - Stream temperature was in the Good category according to the OCD data.

Turbidity - Turbidity was also in the Good range according to OCD data.

Nutrient Loading - Nutrient loading and Chemical Contamination information is a data gap for Reach 2, as well.

In-Channel Habitat

Substrate - Because Reach 2 is not considered to provide anadromous fish habitat, the substrate condition criterion does not apply.

Large Wood - Determination was made by remote sensing, not from on-the-ground data collection. Non-forested habitats are not present within 50 meter buffers on each side of Antoine Creek. There is a data gap regarding the numbers of large woody debris currently present in this reach.

Percent Pools - The total stream length in this Reach is 0.5 miles. The amount of stream channel that has 2% or less gradient is 0.3 miles (60% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is 0.1 miles (20% of the channel length in this reach). The amount of stream channel that is greater than 5% gradient is 0.1 miles (20% of the channel length in this reach). These determinations were made by remote sensing. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The actual number of pools in this reach is a Data Gap. The portion of the channel that is 2% or less in gradient, and the portion that is 2-5% gradient are both located above the fish barrier waterfall, and not available as anadromous fish habitat. Thus, this criterion does not apply.

Habitat Access

Fish Passage - This criterion is not applicable because the reach, due to its high gradient, is not considered to provide anadromous fish habitat.

Stream Flow

Resembles Natural Hydrograph - Stream flow information collected by OCD indicates that this criterion rates Poor, due to the operation of Fancher Dam reservoir for irrigation, which often totally dewaters the channel. In 2000, in addition to being used for irrigation, Fancher Dam reservoir supplied water to extinguish a large wildfire (helicopter buckets, as well as water tender trucks), essentially emptying the reservoir. The OCD sampling site in Reach 2 (below the dam) has had no water between September 2000 and February 2001. The reservoir is being allowed to recharge, with no water being released.

Stream Corridor

Riparian Vegetation - A Data Gap exists regarding the vegetative composition of this reach.
Stream Bank Stability - The stream banks, due to the sideslope steepness have not been altered much over the years. Also due to the steep sideslopes, the channel is confined without much of a flood plain. This criterion rates Good.

Floodplain Connectivity - The stream banks, due to the sideslope steepness have not been altered much over the years. Also due to the steep sideslopes, the channel is confined without much of a flood plain. This criterion rates Good.

Reach 3-

Water Quality-

Dissolved Oxygen - Stream Temperature - Turbidity-
Reach 3 includes all the stream and its tributaries above Fancher dam and its reservoir. The mixing of water in the reservoir changes the oxygen content and the temperature, but that gets changes again upon exit from the reservoir into Reach 2. The water quality of Reach 1 is not affected by that of Reach 3. These criteria are not applicable.

Nutrient Loading - Chemical Contamination and Nutrient Loading for this reach is a Data Gap.

In-Channel Habitat

Fine Sediment - Fine sediment that is delivered down Reach 3 settles in Fancher Dam reservoir, so this criterion is not applicable.

Large Wood - Due to the presence of Fancher Dam and reservoir, the amount of woody debris that may be present in Reach 3 does not affect Reach 1. This criterion is not apply.

Percent Pools - This reach does not affect the reach of Antoine Creek used by anadromous salmonids, so this criterion is not applicable.

Habitat Access

Reach 3 is above two natural fish barriers (a water fall and high gradient riffle), as well as a man-made barrier, Fancher Dam. Thus, this reach is not usable anadromous fish habitat.

Stream Flow

Resembles Natural Hydrograph - Reach 3 flows are not known to be altered. A Data Gap exists regarding the withdrawal of water from Antoine Creek above Fancher reservoir, or from Mill Creek, a major tributary to Antoine Creek. This criterion is rated Good.

Stream Corridor

Riparian Vegetation - Riparian vegetation is in Fair condition , having been altered by agriculture on private lands, road building, and older timer harvest units adjacent to streams on USFS managed lands.

Stream Bank Stability - Stream bank stability is in Poor condition due to livestock movement (hoof shear), roads (Tonasket Ranger District 1996), and conversion of riparian areas to agricultural uses in the private lands.

Floodplain Connectivity - The floodplain connectivity is currently in Fair condition, but is observed to be in a downward trend in the private land portions of Antoine Creek (K. Cooper, personal communication), where livestock appear to have increasing access to the stream channel in the aspen stands and meadows near Havillah.

Tonasket Creek Watershed Assessment

Sub-watershed Overview

The Tonasket Creek watershed encompasses 35,460 acres of mixed ownership. The acres are a mixed ownership as follows: Private ownership, 20,000 acres (56%); Washington Department of Natural Resources, 5700 acres (16%); Bureau of Land Management managed lands, 960 acres (3%); and the remaining 8,800 acres (25%) are managed by the US Forest Service (USFS).

Tonasket Creek enters the Okanogan River east of the city of Oroville, Washington, at River Mile (RM) 77.8 of the Okanogan River. The watershed at its longest axis is approximately 12 miles long and its widest point is approximately 8 miles wide.

Land Use and Ownership

Private lands adjacent to Tonasket Creek are used primarily for orcharding, as range lands, or for agriculture (hay fields). Primary use of USFS, DNR and BLM lands are timber production and/or livestock allotments.

County Road 9480 parallels Tonasket Creek for approximately 9 miles, and a Forest Road parallels the creek for almost 1 mile on the USFS managed lands. There may be more roads adjacent to streams in this watershed. Available maps do not depict all the roads to residences in the area, or for the subdivision being established at Nine Mile Ranch.

Topography, Geology & Soils

Tonasket, Antoine, Siwash and Bonaparte watersheds are all part of the Okanogan sub-continent (Alt and Hyndman 1984). The eastern and southern boundaries are formed by the Columbia River. The western boundary, the Okanogan River valley, is geologically known as the Okanogan trench. The Okanogan sub-continent extends hundreds of miles north into British Columbia, Canada.

The Okanogan sub-continent was an island about the size of California that crashed into the Kootenay Arc (which was then the western edge of the continent), about 100 million years ago. Following this "docking" of the sub-continent came the filling of what was then the "coastal area" on the west edge of the Okanogan sub-continent, the Okanogan trench (now the Okanogan Valley) (Alt and Hyndman 1984). The intersection of these two geologic features (the Okanogan sub-continent and the Okanogan trench) appears to be where barriers of waterfalls or high gradient stream channels occur. These barriers preclude upstream migration of anadromous salmonids.

The elevation of the confluence of Tonasket Creek with the Okanogan River is 910 feet. The highest point in the Tonasket Creek watershed is Wilcox Mountain at 4,378 feet. The Tonasket Watershed is oriented on a southeast to northwest axis.

Tectonic uplifting, continental glaciation, and volcanic ash deposition all played major roles in shaping the existing topography and soils characteristics of this watershed. Continental glaciation has had the greatest impact. Large areas of exposed rock and shallow soils were left as a result of the flow and retreat of the Okanogan and Sanpoil lobes of the Cordilleran Icesheet. Bedrock is overlain by Quarternary glacial till outwash and glaciolacustrine sedimentary deposits of varying thickness.

The upper elevation bedrock is tertiary medium to coarse grain grandiorite and granite of the Mt. Bonaparte pluton.

The lower elevations are underlain with pre-tertiary banded gneiss and schist of the Tonasket gneiss. Both rock types are included in a metamorphosed and structural uplift called the Okanogan gneiss dome (USFS 1998 and 1999).

Vegetation and Riparian Condition

In-channel large woody debris appears to be lacking in much of Tonasket Creek. Non-forested habitat types occur frequently along Tonasket Creek and its tributaries, so it is unlikely large woody debris recruitment would occur from those sites. Streamside vegetation has been altered greatly in the lowest reach where land uses are agricultural. Shrub and forb vegetation are present along much of Tonasket Creek, providing some bank stability and shade cover.

Water Quantity/Hydrology

The following is from the Tonasket Watershed Assessment (USFS 1998) hydrology section:

> Tonasket Creek watershed is characterized by high spring runoff due to melting snowpack that accumulates in late fall and the winter months. Summer and fall runoff is low, fed by the release of stored water from riparian areas in floodplains, seeps, and springs at the headwater tributary streams.
>
> The timing of some run-off has been influenced by the road network that intercepts ground water and re-routes it overland. Some of that surface water reaches drainage ways and leaves more quickly than ground water flow. The interception reduces the amount of late season flow.

Irrigation withdrawals are made in the lower part of the creek. There are likely other water withdrawals from Tonasket Creek and its tributaries in the Nine Mile Ranch subdivision area, as well as Mud Lake Valley and Dry Creek areas. These withdrawals may be for irrigation, stock watering or perhaps domestic use. Tonasket Creek has been channelized through the orchards, and through the alluvial fan to the Okanogan River (K. Williams, personal communication). There may be some domestic use water withdrawals also made from Tonasket Creek.

Water Quality

Tonasket Creek is not on the Washington State List of Threatened and Imperiled Waterbodies (the 303d list).

The following is from the Tonasket Watershed Assessment (USFS 1998) hydrology section:

> Surface stream flow in the lowest reach of Tonasket Creek is often reduced to no flow during the driest part of the year. Tonasket Creek has sometimes been completely dewatered in dry years due primarily to irrigation withdrawals.

About 1.5 miles of stream channel in the Tonasket Watershed are classified as sediment source reaches (USFS 1998). Of that, about 0.75 miles of these reaches are upstream of functional depositional areas. The remaining 0.75 miles of sediment source reaches do not have a functional depositional area between them and the confluence of Tonasket Creek with the Okanogan River.

There is a large wetland on the US Forest Service (USFS) managed lands (at approximately River Mile 13.5) this area filters sediment that might be delivered from upstream.

Anadromous Salmonid Fisheries Resources of Tonasket Creek

Anadromous fisheries resources are restricted to the lower 1.9 miles of the Tonasket Creek sub-watershed due to the steep gradient of the channel that initiates at this point and continues to approximately RM 2.3. Above RM 2.3 (**Figure B-17**), it is suspected that eastern brook trout are present, though some fish shocking done in preparation for the replacement of a culvert on the paralleling County Road 9480 did not reveal any fish (L. Hofmann, personal communication).

Steelhead

Steelhead fry are observed in the confluence area where Tonasket Creek joins the Okanogan River by Ken Williams, Area Fish Biologist Region 2 Washington Department Fish and Wildlife (retired). He surmised that the fry were using the confluence area for rearing, and to evade predators found in the mainstem Okanogan River, and perhaps to make use of relatively warmer water temperatures in Tonasket Creek compared to the Okanogan River (K. Williams, personal communication). An adult steelhead was caught at approximately RM 1.8 in the late 1970s (D. Buckmiller, personal communication).

Chinook Salmon

Summer/fall chinook salmon are known to use the mainstem Okanogan River as well as the Similkameen River to Enloe Falls. The mainstem Okanogan River is used for migration northward to Canadian waters. Most of the known summer/fall chinook spawning areas are in the Similkameen River.

Adult spring chinook salmon (*Oncorhynchus tshawytscha*) in the Upper Columbia Basin are not currently known to use the Okanogan River. The temperature regime at the time spring chinook salmon spawn in the mainstem Okanogan River is too high for successful spawning and rearing. Water temperatures are elevated due to irrigation water withdrawals (K. Williams and J. Spotts, personal communication).

In their Endangered Status of One Chinook Salmon ESU Final Rule (US Federal Register 1999), the National Marine Fisheries Service excluded the Okanogan River from their Endangered species listing for the Upper Columbia Evolutionarily Significant Unit (ESU) of spring chinook salmon. The Okanogan River was excluded from the listing because spring chinook adults are collected as they migrate upstream at Wells Dam on the Columbia River, approximately 20 miles downstream of the confluence of the Okanogan River. The adult salmon are transported to the Winthrop National Hatchery in Winthrop, Washington, and are spawned there. The eggs and resulting fry are raised at the hatchery and later released into the Methow River.

Sockeye salmon

Sockeye salmon are known to use the mainstem Okanogan River as a migration pathway to their spawning areas in Lake Osoyoos and the upstream reaches of the Canadian Okanogan River. Sockeye salmon are not known to use Tonasket Creek.

Bull trout

There are no data or anecdotal information indicating bull trout ever were, or that bull trout currently are, in the Tonasket Creek watershed. Data that does exist suggests that bull trout did not exploit the Okanogan River north of the city of Omak, approximately 30 river miles down-river of the confluence of Tonasket Creek with the Okanogan River (K. Williams, personal communication). The Okanogan River is not suitable habitat for bull trout due to the bull trout requirement of very cold, clean waters with clean gravel/cobble substrate for successful spawning and rearing.

Scott and Crossman (1973) reported that bull trout are not present within the Canadian Okanogan River system.

Habitat Limiting Factors Assessment of the Tonasket Sub-watershed

Tonasket Creek was divided into three reporting units (reaches) in addressing potentially limiting factors to salmonid production for this document (**Table 5-19**).

Reach 1 (from the mouth of Tonasket Creek to River Mile 1.9) is considered usable salmonid habitat provided that there is adequate flow. Reach 1 ends at the base of a long, steep gradient channel that is considered to be a natural passage barrier.

Reach 2 (River Mile 1.9 to RM 13.2) includes the steep gradient channel. This reach ends at a large wet meadow on lands managed by the USFS. This reach has an affect on downstream water quality, but is not considered to be usable habitat for anadromous fish.

Reach 3 (River Mile 13.2 and above) includes Tonasket Creek and all its tributaries above RM 13.2. This reach is entirely on lands managed by the USFS. This reach is inaccessible to fish moving upstream from the Okanogan River.

The following rankings reference habitat criteria accepted by the Okanogan TAG group as most relevant to the production potential of anadromous salmonid fishes in the Okanogan (**Table 5-19**).

Table 5-19. Tonasket Creek Limiting Factors Assessment

Attribute Considered	Anad potential reach 0.0 - 1.9 Reach 1	Water quality reach 1.9 - 13.2 Reach 2	Non-issue reach above 13.2 Reach 3
Water Quality			
Dissolved Oxygen	G1*	G1*	N/A
Stream Temperature	G1*	G1*	N/A
Turbidity/Suspended Sediment	G1*	G1*	N/A
Nutrient Loading	DG	DG	DG
In Channel Habitat			
Fine Sediment (substrate)	G2	N/A	N/A
Large Woody Debris	P2	DG	N/A
Percent Pool	DG	DG	N/A
Habitat Access			
Fish Passage	F2	N/A	N/A
Stream Flow			
Resembles Natural Hydrograph	F2	2	G2
Impervious Surface	G2	G2	G2
Stream Corridor			
Riparian Vegetation	P2	F2	G2
Stream Bank Stability	G2	F2	G2
Floodplain Connectivity	P2	F2	G2

* Okanogan Conservation District (OCD) data

Support for Limiting Habitat Factor Rankings in the Tonasket Creek Sub-watershed

Reach 1-
Water Quality

Dissolved Oxygen - Dissolved oxygen is rated Good based on the 110% saturation level (10.98 mg/l at 15.4^{o}C), as represented in data collected by the Okanogan Conservation District (OCD) from May of 2000 to February 2001. Dissolved oxygen information was collected only when sufficient flowing water is present.

Stream Temperature - Stream temperatures were below 18^{o} C., in the same time period as the DO information was collected.

Turbidity - Turbidity measurements were all less that 20 NTUs. Data was collected in the same time period as the dissolved oxygen information.

Nutrient Loading - A data gap exists for Chemical Contamination/Nutrient Loading.

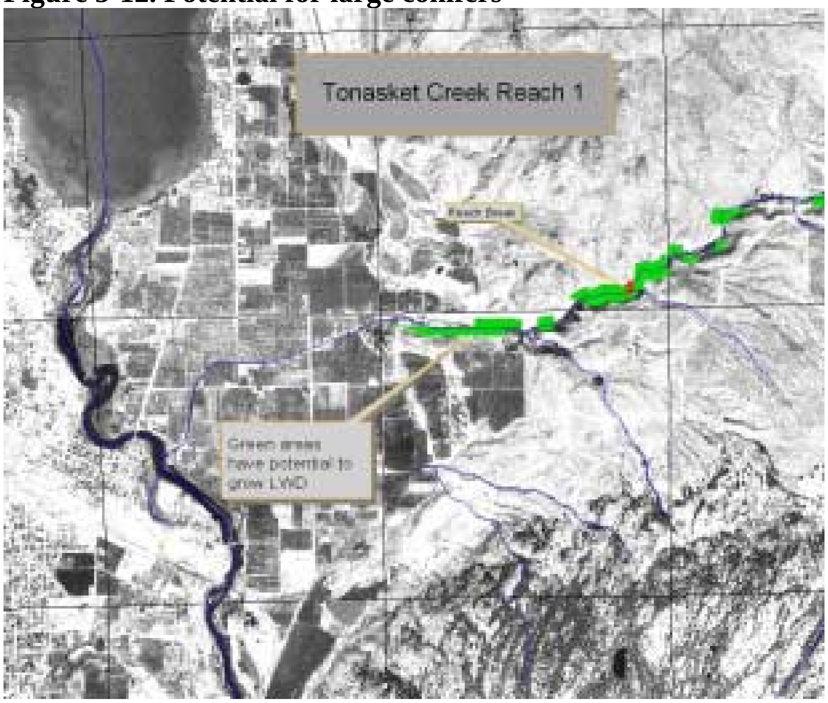
In-Channel Habitat

Fine Sediment - The substrate in the channel on the private lands has not been extensively observed. Spot visual observations (K. Cooper, personal communication) at potential spawning sites reveal the substrate to be in a Good condition.

Large Woody Debris - Sites with potential for providing large woody debris (**Figure 5-12**). Determination was made by remote sensing (GIS/Arcview mapping), not from on-the-ground collected data. Non-forested habitat types comprise 75% of 50 meter wide buffers on each side of

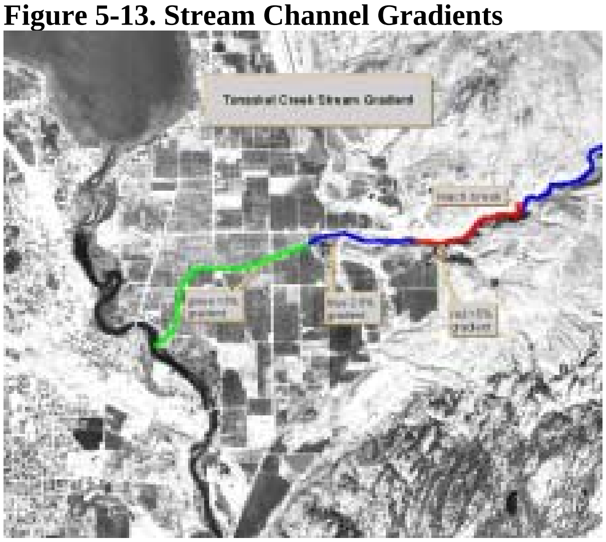
Tonasket Creek. This indicates that the potential for large woody debris recruitment is low. By the matrix definitions, this reach rates Poor for large woody debris, but this rating must be tempered by considering the potential natural condition (non-forested_ along this reach. Trees of a size to be classified as large woody debris are unlikely to grow in non-forested habitat types.

Figure 5-12. Potential for large conifers



Percent Pools – **Figure 5-13** depicts where the stream channel is of a gradient of 2% or less, where it is 2-5%, and where it is greater than 5%. The total stream length in this Reach is 1.9 miles. The amount of stream channel that has 2% or less gradient is 0.9 miles (48% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is 0. miles (26% of the channel length in this reach). The amount of stream channel that is greater than 5% gradient is 0.5 miles (26% of the channel length in this reach). These determinations were made by remote sensing. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The actual number of pools in this reach is a Data Gap.

Figure 5-13. Stream Channel Gradients



Habitat Access

Fish passage is assumed to RM 1.9, the bottom end of the steep gradient channel, whether useable habitat is available beyond that point is a Data Gap. This criterion rated Fair, because the water levels in Reach 1 are known to fluctuate and at times to go dry, though the exact location of the withdrawal(s) is not known.

Stream Flow

Resembles Natural Hydrograph - The stream flow in Reach 1 is altered as a result of water withdrawal, though the exact location of the withdrawal(s) is not known. It is unknown if the withdrawals are direct from the stream channel, or if they are indirect, from the hyporheic zone adjacent to the stream channel(s) (C. Fisher, personal communication). This reach rates Poor for this criterion.

Stream Corridor

Riparian Vegetation - The riparian vegetation in this reach rated Poor, based on spot visual observations (K. Cooper, personal communication). Shade has been greatly reduced in the lower portion of Reach 1, the natural vegetation has been replaced by orchards. In other places agricultural conversion of lands to pastures, and crop lands, has occurred. Trees and other vegetation have also been removed for clearing of the right of way for County Road 9480.

Stream Bank Stability - Stream bank stability is Good, but this is based in part on observation of some rip-rapped stream sideslopes, and trapezoidal maintained stream channel through orchards.

Floodplain Connectivity - Flood plain connectivity is rated as Poor based on spot visual observations (K. Cooper, personal communication). Tonasket Creek has been channelized through orchards and along County Road 9480 for at least 1 mile to the Okanogan River. No flood plain was created when the channel was constructed.

Reach 2-

Reach 2 affects the water quality downstream in Reach 1, but due to its steep gradient is not considered anadromous fish habitat.

Water Quality

Dissolved Oxygen - Dissolved oxygen (DO), as shown in the OCD data (collected May 2000-February 2001) for their sample site in Reach 2 indicates a saturation level of 95% (10.16 mg/l at 13.3^{o} C.), rating this Reach as Good for DO.

Stream Temperature - Stream temperature was in the Good category according to the OCD data.

Turbidity - Turbidity was also in the Good range according to OCD data.

Nutrient Loading - Nutrient loading and Chemical Contamination information is a data gap for Reach 2, as well.

In-Channel Habitat

Substrate - Because Reach 2 is not considered to provide anadromous fish habitat, the substrate condition criterion does not apply.

Large Wood - Determination was made by remote sensing (GIS/Arcview mapping), not from on-the-ground collected data. In Reach 2, non-forested habitat types comprise 13% of 50 meter wide buffers on each side of Tonasket Creek. There is a Data Gap regarding the number of pieces of large woody debris within this reach. It appears the potential for producing large woody debris size class material may be present in this reach.

Percent Pools - The total stream length in this Reach is 11.3 miles. The amount of stream channel that has 2% or less gradient is 2.4 miles (22% of the channel length in this reach). The amount of stream channel that is of 2-5 % gradient is 6.2 miles (56% of the channel length in this reach). The amount of stream channel that is greater than 5% gradient is 2.6 miles (23% of the channel length in this reach). These determinations were made by remote sensing. Where the gradient is 5% or greater, there is less likelihood of large pools than in gradients of 5% or less. The actual number of pools in this reach is a Data Gap.

Habitat Access

Fish Passage - This criterion is not applicable because the reach, due to its high gradient, is not considered to provide anadromous fish habitat.

Stream Flow

Resembles Natural Hydrograph - Stream flow information collected by OCD indicates that this criterion rates Fair. Timing of upstream withdrawals may be the problem.

Impervious Surfaces - Casual observations along this Reach indicate a lack of impervious surfaces, ranking this Reach as being in Good condition.

Stream Corridor

Riparian Vegetation - The vegetation composition of this Reach is rated as Fair, the vegetation has been altered, but still appears to be within 25-50% of the potential natural community composition.

Stream Bank Stability - Because of some streamside alteration of vegetation types, the stream bank stability is considered Fair.

Floodplain Connectivity - The construction and maintenance of the County Road has altered the sideslopes of the creek in places, and as well, the construction of the County Road usurped part of the flood plain. In places where the sideslopes are quite steep, the sideslopes have not been altered much over the years, but in those places, the channel is confined without much of a flood plain. This criterion is considered as Fair.

Reach 3-

Water Quality-

Dissolved Oxygen - Stream Temperature - Turbidity-
Reach 3 includes Tonasket Creek and it tributaries above and inclusive of the wet meadow in T39N, R28E, Section 23, NE¼. The wet meadow intercepts any sediment that might be delivered, and the DO and temperature are altered as a result of the transport in the 11.3 miles of Reach 2. Thus, the water quality (DO, temperature and turbidity) of Reach 1 is not affected by that of Reach 3. The above criteria are not applicable.

Nutrient Loading - Chemical Contamination and Nutrient Loading for this reach is a data gap.

In-Channel Habitat

Fine Sediment - Fine sediment that is delivered down Reach 3 settles in the wet meadow, so this criterion is not applicable.

Large Wood - Large woody debris that may fall into the channel above the wet meadow is not likely to be delivered through the meadow and downstream to Reach 1, so this criterion is not applicable.
Percent Pools - This reach does not affect the reach of Tonasket Creek used by anadromous salmonids, so this criterion is not applicable.

Habitat Access

Reach 3 is above one natural fish barrier (long high gradient riffle), as well as two man-made barriers (a culvert under County Road 9480, and another culvert on Forest Road 3524-100), thus, this Reach is not usable or accessible by anadromous fish.

Stream Flow

Resembles Natural Hydrograph - Reach 3 flows are not known to be altered, so this criterion rates Good.

Impervious Surfaces - Impervious surfaces are not known to be present in Reach 3 (Tonasket Ranger District 1996).

Stream Corridor

Riparian Vegetation - Riparian vegetation is in Good condition (Tonasket Ranger District 1996), with the potential natural community and composition being greater than 50%.

Stream Bank Stability - Stream bank stability is in Good (Tonasket Ranger District 1996).

Floodplain Connectivity - The floodplain connectivity is currently in Good condition (Tonasket Ranger District 1996).

Similkameen River Basin

Sub-watershed Overview

The Similkameen River is the largest tributary to the Okanogan River that originates in the Washington Cascades, flows north into Canada, and loops around to the south into the northern reaches of Okanogan County, Washington. The Similkameen Basin is 666.53 square miles, containing 17 rivers and streams, with a perimeter of 226.89 miles (EPA website). The Similkameen drainage basin is 3600 square miles, 80 percent of which is in the Canadian portion of the watershed (Interim Instream Flow Report, 1986). It is bordered to the south by the Sinlahekin River, which joins the larger tributary at the Palmer Lake Reservoir. The Similkameen watershed is ranked by the USDA as a high priority sub-watershed with a 303(d) listing from the Washington Department of Ecology (WDOE) in 1997 (WDOE 1997).

Land Use and Ownership

The Similkameen River Basin is primarily comprised of forested lands and rangelands. Just as in the Okanogan River Basin, ownership of the Similkameen encompasses public and private lands. The public sector is made up of the US Forest Service, Washington Department of Natural Resources (WDNR) and the US Bureau of Land Management.

There is a total of about 210,000 acres (private and WDF&W estimates not known) of land in the Similkameen and Sinlahekin Basins currently used for grazing. As a result of present and historical overgrazing, the land around the Similkameen shows signs of degradation; in 1982, the Bureau of Land Management classified 32% of the rangeland condition as poor. The livestock cause hoof shear as they travel along the water's edge, and graze out the native plants that would add stability. These two combined activities cause erosion of the streambank and sediment deposition into the river. In 1982, 111.6 miles of the Similkameen and Sinlahekin were assessed for streambank stability, and almost 3% were found to be unstable due to grazing impacts.

Other factors that promote instability in the streambank are active mining, road construction and irrigation. According to the USFS, there are a total of 50.5 miles of road within 200 ft of the Similkameen (WQ management, 2000). These activities lead to increased runoff and less infiltration.

Topography, Geology & Soils

Steep mountainous regions characterize the shape of the Similkameen Basin. The basin is a transitional zone between the Cascade Mountains to the west and Okanogan Highlands to the east (Enloe Hydroelectric Project, 2000). The valley was carved out through glacial activity during the Pleistocene ice age (www.env.gov.bc.ca website). Cordilleran ice sheets and their meltwater also effected the basin's drainage patterns. During the ice sheets migration south from the interior of British Columbia, the advance and retreat activity cut deep narrow canyons. The valley walls climb to elevations around 2,800 ft from the water's edge. There is little water storage, and runoff and floods are quite common.

The Similkameen Basin has a semi-arid climate, with the exception of the western mountainous regions that are relatively wet (Enloe Hydroelectric Project, 1989). The soils in the basin that result from this climate display an assorted diversity.

Fluvial Geomorphology & In-Channel Habitat

The noxious weed, Diffuse knapweed, is an invader species and a serious water quality threat in the Similkameen watershed. The watershed is listed as a Class C river for in-channel vegetation. The introduced species crowd out the native vegetation and create instability along the riverbanks. Noxious weeds are characteristic for having deep tap root systems as opposed to the fibrous roots of the native species. Woody vegetation increases stability by deflecting the water energy away from the bank, thereby retaining the bank soils during high flows.

The Similkameen has the greatest impact on the Okanogan in terms of erosion problems, with an erosion rate of 1.18 acre-ft per square mile. In a Pacific Southwest Interagency Committee (PSIAC) model study in 1998, the Bonaparte Creek and the Similkameen subwatersheds yielded 33% of the total sedimentation yield, even though they cover only 9.5% of the total modeled land area. In 1972 at Nighthawk, six miles above Enloe Dam, average annual suspended-sediment discharge was 134,000 tons per year. The recorded accumulation of sediment from 1920-1972 created an average water level rise of 0.65 feet per year.

Vegetation and Riparian Condition

The vegetation in this semi-arid climate is a mixture of three steppe vegetation zones within four major vegetation communities. High hillsides promote the growth of ponderosa pine with bitterbrush as the dominant understory. On the lower slopes big, sagebrush/bluebunch wheatgrass are found on the gentle rises, while bitterbrush/Idaho fescue community thrives on the steeper, rocky regions. Treetip sagebrush, rubber rabbitbrush, arrowleaf balsamroot, prickly pear, and a variety of grasses are considered to be associate species. The fourth community is made up of smooth sumac and cheatgrass on the slopes above the reservoir.

Water Quantity/Hydrology

Water supply

The total drainage area for the Similkameen River is 3550 mi^2, mostly in the Canadian portion of the basin (Enloe Hydroelectric Project, 1989). This includes two principal drainages on the Washington side: the Pasayten and Ashnola.

There is no principal aquifer in the majority of the Similkameen River Basin, but there are 29 square miles of Pacific Northwest fill aquifers composed of unconsolidated sand and gravel (USGS 1998). There is also a metamorphic, granitic and consolidated sedimentary rock component that has low permeability and porosity (Enloe Hydroelectric Project, 1989).

Streamflow

The Similkameen provides 75% of the average flow to the Okanogan River Basin. Peak flows occur around May to June (8,000-9,000 cfs), with a constant flow around 600-900 cfs the rest of the year. The peak makes up about 61 percent of the annual flow, while the months of August through March make up between 2.2 to 3.3 percent of the total annual discharge (Enloe Hydroelectric Project, 2000). Suspended Sediment flows closely follow streamflow peaks, forming a plateau of 11,500 mg/L between April and June (Okanogan Water Quality Management Plan, 2000). Because it is such a major contributor, the problem of suspended sediment transported in the Similkameen is magnified.

Water Quality

There is one 303(d) listing because of four excursions past the standard out of 34 samples for water temperature between 1991-1996 (Proposed 1998 Section 303(d) List), 1997). The Similkameen River is a Class A River and must hold to these water quality standards. The standard temperature for Class A is 18° C. The Similkameen has been measured above this temperature through most of August and into July. Temperatures required for successful salmon spawning range from 3.9° - 20° C. The Similkameen has temperatures of 22° C (as high as 26 C) in mid-summer, precluding summer rearing by juvenile salmonids (WQ management, 2000).

Anadromous Salmonid Fisheries Resources of the Similkameen Basin

Even though there are problems with sedimentation and water temperature, chinook salmon runs have increased slightly in the Similkameen River and declined in the Okanogan (WQ Management, 2000) (**Figure B-18**). This could be due to the migration barrier that the Conconully Dam provides; passage for salmon runs have been constructed through abandoned power plant, Enloe Dam, 8.8 miles above the confluence with the Okanogan River.

Excess silt and sedimentation has degraded salmon spawning habitat by reducing pool sizes. As the pools become shallower and wider, more surface area is exposed to direct sunlight, increasing temperatures.

Habitat Limiting Factors Assessment of the Similkameen Basin

The following information discusses the factors affecting fish distribution in the Similkameen River (**Table 5-20**).

Table 5-20. Similkameen River Limiting Factors Assessment

Attribute Considered	Anadromous potential, Water Quality concerns
<u>Water Quality</u>	
Dissolved Oxygen	
Stream Temperature	
Turbidity/Suspended Sediment	
Nutrient Loading	
<u>In Channel Habitat</u>	
Fine Sediment (substrate)	
Large Woody Debris	
Percent Pool	
< 2%	
2-5%	
>5%	
<u>Habitat Access</u>	
Fish Passage	
<u>Stream Flow</u>	
Resembles Natural Hydrograph	
Impervious Surface	
<u>Stream Corridor</u>	
Riparian Vegetation	
Stream Bank Stability	
Floodplain Connectivity	

Ninemile Creek Watershed

Sub-watershed Overview

Ninemile Creek Subbasin is in the Northeast corner of the Washington-Canada border of the Okanogan Watershed. The main tributary that forms the subbasin generates from Osoyoos Lake on its western border. The majority of the Ninemile Creek subbasin is in Canada, to the northeast of Osoyoos Lake. The land ranges from arid desert to coniferous forest. No other major bodies of water are found on the Canadian side besides Ninemile Creek.

Land Use and Ownership

The close proximity of Osoyoos Lake to this arid region provides the irrigation needs for orchards in both the US and Canada portions of Ninemile Creek (www.ncw.wsu.edu/PNWTrees, 4/30/01). The major crops consist of apples, pears, sweet cherries, and peaches, while wine grapes are considered more minor crops (www.ncw.wsu.edu/PNWTrees, 4/30/01).

Topography, Geology & Soils

The altitude varies from 300 to 1000 ft from west to east across the subbasin. The Ninemile Valley is comprised of arid terraced land rising across the valley to forested regions on the east edge of the subbasin (www.ncw.wsu.edu/PNWTrees, 4/30/01).

Due to continental and alpine glacial activity, Pleistocene glacial deposits and Holocene alluvial deposits make up the soil structure of the Okanogan watershed (Ecology, 1999). Bedrock is composed primarily of granitic and andesitic rocks, and metamorphosed sedimentary rocks (Ecology, 1999).

Vegetation and Riparian Condition

Ninemile Creek subbasin is in a Montane Cordillera terrestrial ecozone (www.atlas.gc.ca, 4/30/01). On the Washington of the Ninemile subbasin there are two main vegetation types: forest land and shrub/grass land. Along with the elevation gain, the grasslands become forested areas along the eastern fringe. The nearness of the Cascade Range provides a rain shadow for the Ninemile Creek subbasin, forming dry, arid lands with an abundance of water due to snowmelt into the adjacent Osoyoos Lake and Ninemile Creek region (www.ncw.wsu.edu/PNWTrees, 4/30/01).

Water Quantity/Hydrology

Water supply
Streamflow

Water Quality

Ninemile Creek was added to the Washington State 1998 303(d) list for DDT (NW Power Council, 2001). Another parameter of concern is the sedimentation rate, which is at 0.33 ac-ft/mi2. Sedimentation degrades habitat for salmonid species and increases temperatures (NW Power Council, 2001). Ninemile Creek is further north from the confluence of the Similkameen with the Okanogan and so is not influenced by the high levels of sedimentation coming from the Similkameen River.

Anadromous Salmonid Fisheries Resources of Ninemile Creek

The Zosel Dam/Osoyoos Lake region is important during the summer chinook spawning months of September to November (**Figure B-19**). The Similkameen is one of the most productive areas for summer chinook, and according to the 1998 survey of summer chinook redds, a total of 238 redds were counted during the spawning season (Murdoch and Miller 1999). The influence of the Similkameen and Okanogan River close to Zosel Dam creates great potential for tributary escapement into Ninemile Creek branching off to the east of Osoyoos Lake.

Habitat Limiting Factors Assessment of the Ninemile Creek Sub-watershed

The following information addresses the factors affecting fish distribution in the Ninemile Creek sub-watershed (**Table 5-21**).

Table 5-21. Ninemile Creek Limiting Factors Assessment

Habitat Pathway and Indicator*	Limiting Habitat Factor Rankings
Water Quality	
Dissolved Oxygen	
Stream Temperature	
Turbidity/Suspended Sediment	
Nutrient Loading	
In Channel Habitat	
Fine Sediment (substrate)	
Large Woody Debris	
Percent Pool	
Habitat Access	
Fish Passage	
Stream Flow	

Habitat Pathway and Indicator*	Limiting Habitat Factor Rankings
Resembles Natural Hydrograph	
Impervious Surface	
Stream Corridor	
Riparian Vegetation	
Stream Bank Stability	
Floodplain Connectivity	

Summary of Action Item Recommendations by Sub-basin

This chapter provides a bulleted summary of the action item recommendations by sub-watershed, based upon the limiting factors assessment results and data gaps identified in chapter 5. The recommendations provided here are not prioritized, and are based upon the current technical understanding of the Okanogan TAG. Action items are listed for only those sub-watersheds where a significant consensus was secured. Action item recommendations for the Canadian sub-watersheds are beyond the scope of this current effort, but will be addressed in other related forums.

Okanogan Mainstem Action Items

- Address impacts of non-native fishes (e.g., smallmouth bass) on anadromous resource survival.
- Characterize sediment budget
- Secure functional riparian habitats and identify specific areas in need of restoration.
- Reduce mainstem temperatures to tolerable levels

Chiliwist Creek Sub-watershed Action items

- Stabilize flow to ensure cold year-round water at the mouth of the creek. High flows are not necessary.
- Restore sinuosity, decrease channelization.
- Decrease sediment load from roads.

Loup Loup Sub-watershed Action items

As evidenced by the current use of the upper reach of Loup Loup Creek by eastern brook trout and resident rainbow trout, water quality conditions are generally conducive for salmonids to exist. However, passage barriers and altered hydrology effectively eliminate the use of this system by anadromous salmonids except at the confluence of the system with the Okanogan mainstem. Based upon the limiting factors discussion and tabulation provided in section 5.3, the following (unprioritized) action items are recommended to improve habitat conditions in the Loup Loup sub-watershed. in contrast, the lower reach (RM 0 to ~ 2.5) of Loup Loup Creek has several factors that limit the ability for salmonids to become reestablished. Two fish passage barriers (~ RM 0.1 and 0.25) impede upstream migration by adult steelhead thus preventing natural reproduction for this endangered species. Furthermore, flows at ~ RM 2.0 are diverted for irrigation during the irrigation season and thus causing flows to become non-existent in this lower reach by mid-summer. Thus, before Loup Loup Creek can be beneficial to the recovery of anadromous salmonids particularly for summer steelhead, continuous flows need to be provided in the lower reach in sufficient amount for incubation and juvenile survival and current barriers need to modified or removed for migrating adult steelhead to access this lower reach.

- Formally evaluate fish passage conditions in system proceeding from the mouth upstream to the first natural blockage (RM 2.5).
- Examine water use in basin and eliminate excess uses water to re-establish flow regimes where possible in naturally anadromous zones
- Correct human-caused fish passage blockages as identified from further study, in concert with flow remediation to lower creek below falls at RM 2.5.
- Conduct quantitative habitat assessment study to identify functional and non-functional reaches and to prioritize habitat reaches for practicable in-channel and stream corridor (i.e., riparian) restoration.
- Examine Tallant Creek for potential habitat value through quantitative study. Identify source(s) of DDT contamination and determine if continued DDT contamination prevents or limits function of system for anadromous salmonids
- Reestablish anadromous fish by eradicating brook trout in upper waters. Reestablish historic steelhead routes by establishing stable flow.

Felix Creek Action Items

- Address report of illegal water withdrawal.

Omak Creek Action Items

- Create a sediment control program to limit sedimentation rates.
- Explore land use ordinances to improve water temperatures in lower reach (RM 0-5.1). Implement fencing, planting, and livestock management programs.
- Reduce road densities, decommission roads in the upper basin.

Salmon Creek Action Items

- Restore hydrologic regime that supports life cycles through Salmon Creek in the reach below the diversion dam (RM). Would support spring chinook and summer steelhead migration.
- Improve passage facilities at the OID diversion dam (RM).

Wanacut Creek Action Items

- Regulate irrigation water withdrawals to maintain consistent flows through subbasin.

Johnson Creek Action Items

Tunk Creek Action Items

Chewiliken Creek Action Items

Aeneas Creek Action Items

- Maintain water temperature. Aeneas Creek is a good rearing/refuge for sockeye migrating up to Osoyoos Lake.
- Create land use regulations to ensure good water quality.
- Maintain low irrigation use (low number of diversions).
- Gain more flow.
- Passage issues reach #1. If barrier is removed would there be spawning in Aeneas Creek? Removal would only open ¼ mile up to the falls (natural barrier). There are high $CaCO_3$ levels in Aeneas Creek.

- Improve wood loading (low priority item).

Whitestone Creek Action Items

Bonaparte Creek Action Items

- Control sediment delivery. Identify sediment source control.
- Plant in areas of bank erosion next to roads.
- Create land management policies for private owners (i.e. fences to prevent cattle from going in the stream).

Siwash Creek Action Items

Antoine Creek Action Items

- Build storage reservoir to permit better flow regulation downstream of the dam. For example, improving flows through Fancher dam would help passage issues.
- Reestablish the natural channel in Reach 1 (RM 0-1.5).

Tonasket Creek Action Items

- Improve low streamflows by limiting/regulating water withdrawals.
- Preserve condition that benefit aquatic resources created by isolated events.
- Maintain habitat quality/quantity.

Similkameen River Action Items

Ninemile Creek Action Items

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Subbasin Management

The anadromous fish species targeted for management in the Okanogan Basin are spring chinook, summer chinook, sockeye, and summer steelhead. The goal is to restore sustainable, naturally producing populations to support tribal and non-tribal harvest and cultural and economic practices while protecting the biological integrity and the genetic diversity of the watershed.

In an attempt to meet the subbasin goal, land managers have adopted the following outcome-based objectives:

1. Improve adult survival and
2. Improve juvenile survival.

Chinook

The broad strategy for reintroducing and protecting Okanogan spring chinook combines habitat protection, passage improvements, harvest management restrictions, and supplementation with artificial production. Specific strategies include improving habitat through the use of habitat restoration and passage improvements, and supplementing naturally spawning populations to enhance natural production.

The Confederated Tribes of the Colville Reservation (CTCR) are preparing comprehensive plans now to reintroduce spring Chinook into the Okanogan basin and to expand the propagation of summer/fall Chinook in the basin. These programs are being undertaken to achieve CTCR goals of restoring naturally spawning populations of Chinook salmon in their historic habitats, providing reliable and predictable runs of hatchery-origin Chinook to support ceremonial and subsistence (selective) fisheries, and local recreational (selective) fisheries.

For spring Chinook, the CTCR are currently investigating six strategic options (see Appendix O). The preferred alternative being analyzed would create both an “integrated recovery” program to restore naturally spawning populations in their historic habitats and an “isolated harvest” program to create a hatchery-origin run of salmon to support the basin fisheries. These programs would be initiated with Carson stock to assess habitat viability and provide for immediate harvest benefits and then transition to Methow Composite stock when hatchery programs in the Methow basin create a surplus to the needs of that basin.

The Methow stock would only be used if it could be planted in the Okanogan basin as an "experimental population" under the Endangered Species Act (ESA). An experimental population of ESA-listed spring Chinook could aid in the de-listing and recovery of an endangered species without the take prohibitions normally associated with a listed species. This would increase the likelihood of local support for species reintroduction and provide the management flexibility for harvest and habitat improvement.

For summer/fall Chinook, the CTCR are considering several options for further development (see Appendix R). The current preferred alternative includes several programs. These are 1) an "integrated harvest" program to increase supplementation into underutilized habitats and support selective fisheries in the Okanogan basin, 2) an "integrated recovery" program to initiate propagation of later arriving summer/fall Chinook for planting into underutilized habitats, and 3) expanding an "isolated harvest" program to provide more salmon for the subsistence fishery located below Chief Joseph Dam.

New, expanded, and reprogrammed hatchery facilities combined with new acclimation facilities will be necessary to support these Chinook programs. The CTCR intends to soon complete Hatchery & Genetic Management Plans that will describe and analyze the strategic options and detail a preferred alternative to meet their and co-manager goals.

Sockeye

The CTCR manages the Cassimer Bar Hatchery with the goal of restoring sockeye stocks. In addition, since 2000 the CTCR has been funded by BPA to conduct a pilot study to assess the viability of using Ska'ha Lake in B.C. for sockeye production.

Steelhead

Efforts to restore and maintain steelhead populations and habitat include the hatchery programs outlined in Table X (in section titled Artificial Production), and habitat restoration projects on Omak and Salmon creeks.

The Okanogan Conservation District strongly endorses the voluntary Coordinated Resource Management planning process for managing natural resources. In the Okanogan Watershed Management Planning Area there are 15 active Coordinated Resource Management planning groups with another eight planning groups starting up in the next five years in the Omak Creek Watershed. These local planning groups operate within a framework of existing laws and regulations. They can assist and work with, but not over-ride, the decision-making authority of those responsible for public and private lands and resource management. The process provides for a voluntary coordination of activities toward common objectives and solves management problems through plan implementation.

USDA Forest Service

The Tonasket Ranger District, in the Okanogan and Wenatchee National Forest, manages 357,000 acres in the Okanogan Basin. The land is managed according to the Okanogan National Forest System Land and Resource Management Plan (USDA, 1989), as amended by the Decision Notice for the Interim Strategies for Managing Anadromous Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH) (USDA, USDI 1995). Most of the National Forest land is mid to upper elevation forest. The 1989 Forest Plan divides the land into management areas, each with a management prescription based on unique habitat conditions. The majority of

National Forest land is managed for multiple uses, including lynx habitat, deer winter range, timber, and livestock grazing. A small portion of National Forest land in the northeast corner of the district is designated Wilderness, with no motorized equipment allowed. There is also a small parcel of land designated as a Research Area, and another relatively small parcel is managed as semi-primitive, with no motor vehicles allowed.

The USFS Tonasket Ranger District maintains 42 cattle allotments on National Forest land.

USDI Bureau of Land Management

The BLM management follows the same legal multiple-use mandate that guides the U.S. Forest Service. Management direction is outlined in the Spokane District Resource Management Plan (USDI, 1987), as amended by PACFISH (USDA, USDI, 1995). BLM lands in the basin include two large areas in the Similkameen and Salmon watersheds, and numerous small, scattered parcels throughout the basin. Management is centered on the two large areas; the scattered parcels are used primarily in land exchange deals.

Washington Department of Natural Resources

The WDNR manages 134,000 acres in the Loomis Forest. The Chopaka Natural Reserve, in the Loomis Forest, is a 3,000-acre natural preserve area. In the year 2000, two parcels totaling 25,000 acres were designated as Natural Areas, with access for recreation and grazing. The remaining area in the Loomis Forest is managed for multiple uses, including timber harvest and livestock grazing. There are 15 million board feet harvested annually from the Loomis Forest (C. Johnson, personal communication, 2001).

Washington Department of Fish and Wildlife

The WDFW maintains five wildlife areas in the Okanogan Basin (Table 29).

Table 29: Washington State Wildlife Areas in the Okanogan Basin.

Wildlife Area	Acreage	Major habitat components
Sinlahekin Wildlife Area	14,000	Riparian, sagebrush steppe, forest
Scotch Creek Wildlife Area	9,200	Sagebrush steppe
Tunk Creek Wildlife Area - subunit of Scotch Ck	1,000	Sagebrush steppe, low elevation, open forest, riparian
Driscoll Island Wildlife Area- subunit of Scotch Ck	260	Riparian
Chiliwist Wildlife Area - subunit of Methow	4,200	Sagebrush steppe, low elevation forest
Chesaw Wildlife Area - a part of the Scotch Ck Wildlife Area, but not within the Okanogan Basin	4,800	Sagebrush steppe

Sinlahekin Wildlife Area

The Sinlahekin Wildlife Area encompasses most of the Sinlahekin Valley. The upper boundary reaches the tops of valley cliffs in some areas, and the base of the cliffs in other areas. It is the oldest wildlife area in the state of Washington, and the original objective of the acquisition was to provide mule deer winter range and outdoor recreation opportunities, namely fishing and hunting. Currently, wildlife viewing is also considered one of the objectives of the area. The Sinlahekin Wildlife Area does not have a management plan. The area provides habitat for a wide variety of wildlife, as reflected in the wide variety of habitat. A primary goal for this area is to reintroduce fire into the ecosystem. The ponderosa pine habitat has been replaced by dense stands of suppressed Douglas-fir. The first step to fire reintroduction, thinning these stands, is currently underway. The Sinlahekin Wildlife Area is actively pursuing habitat and wildlife assessment. Surveys for bats, small mammals, reptiles, and amphibians, and vegetation inventories are planned for 2001 (Swedberg, 2001, personal communication).

Scotch Creek Wildlife Area

In 1991, the WDFW purchased 15,469 acres in a total of 3 parcels of critical habitat for Columbian sharp-tailed grouse. Named the Scotch Creek Wildlife Area, it includes parcels on Scotch Creek, in the Tunk Valley, and the Chesaw Valley. The primary management objective for the wildlife area is the recovery of sharp-tailed grouse habitat and the remnant grouse populations. Preservation of mule deer habitat is also a major focus. The Washington Wildlife and Recreation Coalition funded this acquisition.

As a working cattle ranch, much of the uplands in this area were converted from native shrub-steppe grassland to grain fields of rye or wheat. Later these fields were seeded for livestock grazing. The native rangeland has been severely over-grazed, allowing the encroachment of diffuse knapweed and Russian knapweed. Deciduous trees (primarily water birch) were removed along the riparian corridor to accommodate alfalfa production. This practice drastically reduced critical wintering habitat for sharp-tailed grouse.

The Driscoll Island parcel is located in the Okanogan River channel. There is a ford that gives access to this area. The island contains riparian habitat and a farming operation. There is a project proposal in place to address lateral erosion and its impacts on instream habitat (Swedberg, 2001, personal communication).

The Scotch Creek Wildlife Area Management Plan was approved by BPA in 1997. Since that time, restoration and enhancement efforts have included planting shrubs, weed control, and grassland seedings (Okanogan Conservation District, 2000).

Chiliwist Wildlife Area

The Chiliwist Wildlife Area, a subunit of the Methow Wildlife Area, contains sagebrush steppe and low elevation, open forest.

Confederated Tribes of the Colville Reservation

The Colville Indian Reservation encompasses 1.4 million acres of land held in Federal Trust for the tribal membership, as well as an additional 1.5 million acres of ceded land north of the reservation called the North Half, where tribal members retain hunting, fishing and gathering rights in cooperation with the state and federal agencies involved. The Confederated Tribes of the Colville Indian Reservation (CTCR) also have wildlife management interests and input on Usual/Accustomed Areas of the Wenatchipam, traditional lands of the Moses Columbia Reservation (MCR) and Arrow Lakes lands. On the western third of the Colville Reservation, 344,146 acres of tribal land fall within the Okanogan Subbasin drainage. This land, within the reservation, is comprised of 56% shrub-steppe or open canopy, while 23% is in thin canopy coniferous forest, 14 % provides wooded forage and hiding cover, and 6% is dense forested thermal cover. The tribe is likewise interested and involved in the management of and impacts upon resources on the portion of the Okanogan Subbasin that lies within the boundary of the North Half as well. This massive tract of land, inclusive of both tribal, ceded, and traditional areas, supports viable breeding and/or migratory populations of state and federally listed species of concern, threatened or endangered. Within the boundary of the reservation, in the Okanogan drainage, the number of listed species includes but is not limited to at least 32 species of wildlife, 2 species of fish, and 71 species of plants. An additional 25 species of wildlife found in this area are listed on the Washington State Priority Habitat and Species list (PHS). The CTCR also maintain a strong interest in and manage for plant, fish, and animal species of cultural, spiritual, and subsistence value. The CTCR strive to maintain viable populations of native and desired non-native desired wildlife species and their habitats, while providing wildlife in sufficient numbers to meet the cultural, subsistence and recreational needs of tribal members (CTCR, 1999).

Upper Columbia Salmon Recovery Board

The Upper Columbia Salmon Recovery Board (CSRB) is a partnership among Chelan, Douglas, and Okanogan counties, the Yakama Nation, and Confederated Tribes of the Colville Reservation in cooperation with local, state, and federal partners. The mission of the UCSRB is to restore viable and sustainable populations of salmon, steelhead, and other at-risk species through the collaborative efforts, combined resources, and wise resource management of the Upper Columbia Region.

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A Regional Technical Team (RTT) was created by the UCSRB to review the technical merits of projects to be submitted by project sponsors in the Upper Columbia Region for funding by the Washington State Salmon Recovery Funding Board (SRFB). The UCSRB directed the RTT to establish a scientific framework for this process, with the premise that it will enable them to identify projects that will best contribute to the recovery of salmonids listed under the ESA. A proposed strategy to protect and restore salmonid habitat in the Upper Columbia Region was developed through this process (UCRTT 2001).

Transborder Coordination and Ecosystem Planning Processes

Existing transboundary planning includes three distinct efforts: the Douglas County Project, the South Okanogan-Similkameen Conservation Program, and the Columbia Basin Ecoprovince Review and Subbasin Planning Process. These efforts have the potential to form an interconnected network that can function as a safety net for habitat conditions in the basin (Huntley, 2001). There is also a recent collaboration agreement between the Colville Business Council and the Okanagan Nation Alliance, and a Pacific salmon treaty between the governments of Canada and the U.S.

Douglas County Project

As a condition of the Federal Energy Regulatory Commission (FERC) license to operate the Wells Dam on the Columbia River, the Douglas County Public Utility District (Douglas County PUD) must meet a specific mitigation requirement to compensate for the impacts of dam operation. In regards to sockeye salmon, the PUD must improve productivity over the 20-year average by roughly 10 percent. Douglas County PUD recognized the potential of improving stocks by concentrating on spawning and rearing habitats— which happen to lie in B.C. A contact group was formed in B.C., called the Okanagan Basin Technical Working Group, to assess available measures. The project involves representatives of the Canadian Department of Fisheries and Oceans, Ministry of Environment, Land, and Parks (MELP), and Okanogan Nations Alliance through research contracts. The Project operates on consensus, firmly rooted in biologically defensible goals. Since the initial contact, Douglas County PUD commissioned a variety of studies, many of which are to be finalized in 2001.

The Working Group is the steering force of the project, and consists of both U.S. and Canadian representatives of various interests. The Working Group coordinates the activity of its member agencies for this program. The funding from Douglas County PUD, however, goes directly to the Working Group members through their respective managing entities. This establishes channels for future on-the-ground activity, since the contract recipients are the individuals that will be making the management decisions.

While the project tries not to exclude any participants from decision-making, the small group of people involved is not widely representative. Significant sectors are not currently included, such as other U.S. interests and non-governmental organizations on both sides of the border. Also, Douglas County PUD is aware of the peculiar dynamic implicit in the arrangement—namely that resource managers in B.C. are engaged in helping the utility district to handle its mitigative responsibility in the U.S.

The Douglas County Project has encountered several obstacles, including political concerns, the international border, implications of the project in terms of the Pacific Salmon Treaty (PST), and bureaucratic inertia.

South Okanagan-Similkameen Conservation Program

The South Okanagan-Similkameen Conservation Program (SOSCP), was created by MELP and Environment Canada in July 2000 out of an existing management strategy for the basin, coordination of the Nature Trust of B.C.'s South Okanagan Critical Areas Program, and the MELP's Habitat Conservation Fund Okanagan Endangered Species Program. In the early 1990s, the strategy set priorities for management activities for the conservation of natural habitat and fish and wildlife. The strategy prioritized biophysical mapping projects, species status reports, and opportunities for stakeholder participation.

SOSCP was created to eliminate the redundant work performed by individual recovery teams working toward single species recovery. SOSCP adopted an ecosystem perspective and intends to coordinate existing conservation strategies, negotiate the acquisition of priority habitats, and expand community involvement through partnerships. SOSCP is a relatively new organization and its structure has yet to take shape.

SOSCP's membership now includes 19 organizations. SOSCP seeks out public involvement, and is planning to work with community members to reach common goals. Environment Canada announced in June 2000 that it will contribute $1 million dollars from its Habitat Stewardship Program to fund a variety of SOSCP activities.

Columbia Basin Ecoprovince Review and Subbasin Planning Process

The Columbia Basin Ecoprovince Review and Subbasin Planning Process (ERSPP) is an emerging process that coordinates priorities across the border. Largely a collaboration of government agencies, ERSPP works on the watershed level to set mitigation and restoration priorities and channels federal funds to programs in a strategic method.

The ERSPP is an internal mechanism for Northwest Power Planning Council (NPPC) review of project funding proposals submitted from throughout the region. The review process incorporates independent scientists and regional resource managers from the U.S. ERSSP will fundamentally restructure the planning boundaries, and Canadian officials will now be able to participate in the planning process and coordinate ERSPPs guidelines with their own. In the Okanogan, a group of managers, consultants, and government officials has already begun the subbasin planning process. The membership remains heavily rooted in the U.S., but the group is trying to include additional Canadian perspectives.

ERSPP implements the new ideological interpretation of NPPC's jurisdiction, incorporating Canadian federal and provincial managers and tribes in this process for the subbasins, like the Okanogan, that extend across the border. The ERSPP uses a three-year rolling review for subbasin plans. After the planning processes are completed at the subbasin level, the subbasin will submit a list of projects for funding with its plan to the NPPC. In this way, NPPC is able to maintain a focus on ecoprovincial and regional planning, leaving the smaller scale issues to those better prepared to address them.

The Okanogan River Basin is one of the 52 subbasins subject to planning under ERSPP. Participants in ERSPP describe it as the best example of the ERSPP's transboundary capacity. A good example of potential transboundary projects under the new process is a sockeye project spearheaded by the Colville tribe. The project aims to reintroduce sockeye into Ska'ha Lake, while maintaining the hatchery on the Colville Reservation. The CCT offered to act as a sponsor to make additional resources available to Canadian agencies. At present, the Canadian Department of Fisheries and Oceans is contracted to perform a disease risk analysis and MELP and others will assist with data collection.

Treaty Between The Government of Government of Canada and the Government of the United States of America Concerning Pacific Salmon.

Annex IV Chapter 1 Transboundary Rivers

8. Recognizing that stocks of salmon originating in Canadian sections of the Columbia River constitute a small portion of the total populations of Columbia River salmon, and that the arrangements for consultation and recommendation of escapement targets and approval of enhancement activities set out in Article VII are not appropriate to the Columbia River system as a whole, the Parties consider it important to ensure effective conservation of up-river stocks which extend into Canada and to explore the development of mutually beneficial enhancement activities. Therefore, notwithstanding Article VII, paragraphs 2, 3, and 4, the Parties shall consult with a view to developing, for the transboundary sections of the Columbia River, a more practicable arrangement for consultation and setting escapement targets than those specified in Article VII, paragraphs 2 and 3. Such arrangements will seek to, *inter alia*,:

(a) ensure effective conservation of the stocks;
(b) facilitate future enhancement of the stocks on an agreed basis; and
(c) avoid interference with United States management programs on the salmon stocks existing in the non-transboundary tributaries and the main stem of the Columbia River.

Collaborative development of a regional resolution to address fish passage issues at Enloe Dam

On March 29, 2001, The Colville Business Council and the Okanagan Nation Alliance signed a joint letter of commitment, quoted here:

In this joint letter of commitment, the Colville Business Council and the Okanagan Nation Alliance commit to the collaborative development of a regional resolution to fish passage issues at Enloe Dam, and working with the Upper and Lower Similkameen Indian Bands in particular to protect related fishing rights and interests. The collaborative activities will include working together on common fisheries interests to facilitate a broader ecosystem approach to fisheries, focusing on common restoration programming in the Okanagan-Similkameen sub-basin.

Collaborative fisheries programming will address long-term ecosystem perspectives in the restoration of the subbasin and the region's tribal/First Nation's fisheries. Restoration programming may consider subbasin fisheries as part of broader collaborative fisheries programming in the Columbia watershed, and in the Upper Columbia Watershed in particular. Key elements of the collaborative programming will address, although are not limited to the following:

- Protection of fishing rights and interests
- Rehabilitation of the watershed's aquatic environments
- Cooperative conservation and management of common fisheries interests
- Development of the regions' tribal/First Nation's fisheries.

The Council confirms its respect for the spiritual prohibitions against salmon passage at Enloe Dam, and the need to involve the Upper and Lower Similkameen Indian Bands in related policy and program planning.

Goals, Objectives, and Strategies

Existing Goals, Objectives, and Strategies

The goals, objectives and strategies that follow are taken directly from documents prepared by the federal, tribal, state, and other entities present in the subbasin.

Washington Department of Fish and Wildlife

Sharp-tailed grouse

Goal: Recover populations of sharp-tailed grouse to the level where populations are viable (WDFW 1995b).

- **Objective 1:** Conduct research on sharp-tailed grouse through 2005 to monitor population size, determine population viability, and evaluate population responses to habitat alteration.
  - **Strategy 1:** Monitor all traditional sharp-tailed grouse display sites (leks) on an annual basis
  - **Strategy 2:** Collect and examine tissue samples of sharp-tailed grouse to monitor genetic heterogeneity and population viability.
  - **Strategy 3:** Evaluate movement of radio-marked sharp-tailed grouse to examine population viability and habitat connectivity.
  - **Strategy 4:** Monitor changes in sharp-tailed grouse populations in relation to habitat restoration activities.
- **Objective 2:** Improve quantity, quality, and configuration of the shrubsteppe habitat necessary to support a viable population of sharp-tailed grouse by 2010.
  - **Strategy 1:** Improve CRP plantings throughout the subbasin so that they meet standards for plant composition and for distribution and configuration in relation to shrubsteppe habitat.
  - **Strategy 2:** Continue restoration of habitat on public lands and education of private landowners about restoration opportunities on private land.
  - **Strategy 3:** Purchase properties or easements based on their applicability to published objectives for management and recovery plans for sharp-tailed grouse.
- **Objective 3:** Use translocations of sharp-tailed grouse into Washington from populations in other states.
  - **Strategy 1:** Select a source population in another region based on genetic similarity to birds in Washington.
  - **Strategy 2:** Translocate sharp-tailed grouse into portions of the Okanogan subbasin where they are currently absent.

Strategy 3: Translocate sharp-tailed grouse into portions of the UMMS where population and/or genetic augmentation will be useful for long-term improvement in population viability.

Strategy 4: Monitor and evaluate the success and/or failure of all translocation activities.

Burrowing Owl

Goal: Halt the decline of burrowing owls, increase distribution of burrowing owls to include many of the historic regions occupied in the Columbia Basin, and maintain a stable population of burrowing owls in Washington.

Objective 1: Determine factors limiting burrowing owl populations in Washington.

Strategy 1: Investigate burrowing owl habitat selection in native habitats. Determine factors influencing burrow occupancy and burrow fidelity in native habitats.

Strategy 2: Investigate winter habitat and survival of burrowing owls on winter ranges.

Strategy 3: Evaluate nesting productivity, natal recruitment, and annual survival in eastern Washington. Compare these parameters between large, stable colonies and more ephemeral sites. Also compare these parameters between native and disturbed habitats used.

Strategy 4: Monitor year round movements and long-term survival through marking and radio- telemetry. Determine dispersal distances and colonization potential of adjacent areas.

Objective 2: Develop conservation measures to protect burrowing owls.

Strategy 1: Develop management strategies for continued occupancy and enhancement of both native and disturbed habitats, like irrigation canals, golf courses, and other disturbed habitats.

Strategy 2: Evaluate the usefulness of artificial burrows in enhancing and re-establishing burrowing owl colonies in both native and disturbed habitats.

Strategy 3: Determine management strategies for re-establishment, augmentation, and re-colonizing unoccupied habitats.

Washington Ground Squirrel

Goal: Recover populations of Washington ground squirrels in the UMMS to the level where populations are viable.

Objective 1: Determine distribution and abundance of Washington ground squirrels the UMMS.

Strategy 1: Monitor all known Washington ground squirrel populations annually.

Strategy 2: Conduct regular searches for ‘new’ and or additional populations of Washington ground squirrels.

Strategy 3: Determine habitat characteristics at occupied and unoccupied colonies.

Strategy 4: Evaluate the effects of habitat management on Washington ground squirrels.

Objective 2: Develop habitat management strategies for Washington ground squirrels and incorporate specific management objectives into Wildlife Area and landscape plans.

Ferruginous Hawk

Goal: Recover ferruginous hawks from threatened status by maintaining a population of at least 60 nesting pairs statewide, including at least 10 pairs in the North Recovery Zone (WDFW 1996a).

Objective 1: Improve our understanding of the suitability and security of ferruginous hawk nesting habitats (see Goal 3.1 and research topics in section 7 of Recovery Plan, WDFW 1996a).

Strategy 1: Investigate ferruginous hawk occupancy and productivity characteristics in relation to jackrabbit and ground squirrel distribution and abundance in shrubsteppe habitats.

Strategy 2: Investigate rates of prey delivery, food habits, and adult nest attendance to nestling survival through video monitoring.

Strategy 3: Evaluate habitat alteration and human activity relationships to ferruginous hawk productivity and occupancy, including the efficacy of existing platform nests erected to enhance nesting.

Objective 2: Assess the importance of survival rates and contaminants of adult and juvenile ferruginous hawks to low rates of nest occupancy, and relate these to hawk movements (see Goal 3.1 and research topics in section 7 of Recovery Plan, WDFW 1996a).

Strategy 1: Capture and take blood samples from adult and juvenile hawks for pesticide analysis.

Strategy 2: Monitor year round movements and long-term survival through marking and satellite telemetry.

Objective 3: Improve ferruginous hawk nest occupancy by identifying and promoting protection and enhancement (i.e., erect nest platforms) of the highest quality nesting habitats based on assessment of prey, survival, and human activity. Refine recommended spatial and temporal management buffers around nests and provide site specific recommendations for nest protection.

Northern Leopard Frog

Goal: Conserve the remaining populations of northern leopard frogs in Washington and reestablish additional populations (WDFW, 1996b).

Objective 1: Develop needed information on distribution, habitat and relationships with other species, and implement recovery of leopard frogs.

Strategy 1: Complete surveys and determine specific distribution of northern leopard frogs.

Strategy 2: Investigate breeding, migratory, and over-wintering habitat relationships of northern leopard frogs.

Strategy 3: Evaluate range of suitable habitats, juxtaposition of habitats, and appropriate conditions for northern leopard frogs.

Strategy 4: Determine effects of non-native fish and introduced bullfrogs on northern leopard frogs.

Strategy 5: Determine effects of wetland restoration projects for waterfowl on northern leopard frogs.

Objective 2: Plan and implement recovery programs, translocations and re-establishment of leopard frogs throughout the historic range of the species.

CTCR Objectives and Strategies

Goals, objectives, and strategies of the CTCR are outlined in detail in the Integrated Resource Management Plan (CTCR, 1999). Several key objectives are listed here.

Goal: Manage sharp-tailed grouse populations on the Colville Reservation

Objective 1: Reestablish sharp-tailed grouse to their historic range within the boundaries of the Colville Reservation, increasing the population to over 10,000 birds distributed over 60,000 acres within the Okanogan Basin

Strategy 1: Restore deciduous (winter range), grassland and steppe habitats

Strategy 2: Manage range lands to maintain or enhance the habitats required by the sharp-tailed grouse.

Goal: Assess and protect neotropical bird populations and their habitat

Objective 1: Conduct surveys to assess neotropical bird populations and their habitat. There is presently little data available to determine the limiting factors on bird populations and their habitat.

Objective 2: Support and enhance habitats for migrating bird populations

Strategy 1: Enhance riparian corridors along the major rivers within the basin

Strategy 2: Prevent fragmentation of critical habitats used by neotropical birds

Goal: Maintain or restore the habitat of native plants while preventing the spread of noxious weeds and other undesirable vegetation.

Objective 1: Minimize the spread of noxious weeds

Strategy 1: Implement mechanical, physical, chemical, and biological actions to reduce or remove undesirable species.

Goal Maintain and protect instream and riparian habitat and support ecological function in these habitats.

Objective 1: Identify key ecological attributes specific to the Okanogan subbasin.

Objective 2: Maintain adequate stream flow in the Okanogan Watershed to support salmonids at all life stages.

Strategy 1: Explore water conservation strategies to increase water use efficiency.

Strategy 2: Develop a water market in the Okanogan Subbasin.

Objective 3: Reduce summer water temperatures in the Okanogan Watershed to meet the needs of salmonids in all life stages.

Strategy 1: Identify priority areas for riparian protection and restoration.
Strategy 2: Restore existing riparian habitat to buffer stream temperatures.
Strategy 3: Explore water conservation strategies to increase water use efficiency.

Goal: Establish production-related strategies for salmon recovery and maximize reproductive potential of salmonids.

Objective 1: Maximize reproductive potential of steelhead in the Okanogan Subbasin.

Strategy 1. Explore feasibility of steelhead kelts reconditioning to allow repeat spawning.

Objective 2. Supplement Okanogan Basin spring chinook and steelhead populations as necessary to effect recovery while conserving genetic integrity.

Strategy 1: Explore all possible actions to reintroduce and recover spring chinook in the Okanogan Subbasin.
Strategy 2: Explore all possible actions recover sockeye salmon in the Okanogan Subbasin.
Strategy 3: Collect local wild brood stock and develop acclimation sites.

Objective 3: Identify opportunities and actions to affect transborder cooperation between the U.S. and Canada

Upper Columbia Salmon Recovery Board

The following goals and objectives of the Upper Columbia Salmon Recovery Board are outlined in the UCSRB Strategy Document (UCSRB, 2001).

Goal: Restore the complexity of the stream channel and floodplain in the Okanogan Subbasin.

Objective 1: Allow unrestricted stream channel migration, complexity, and flood plain function.

Strategy 1: Provide fish access to disconnected stream sections or oxbows,
Strategy 2: Remove dikes (or similar structures) that prevent stream channel migration,
Strategy 3: Change the points of origin for problematic water withdrawals to less sensitive site(s),
Strategy 4: Screen water intakes to prevent impingement or stranding of juvenile fish,
Strategy 5: Purchase water shares for instream flow and water quality benefits,
Strategy 6: Provide alternative sources of irrigation and domestic water to mitigate impacts of problematic surface water diversions,
Strategy 7: Remove passage barriers,
Strategy 8: Use mechanical means to encourage natural development of riparian areas,
Strategy 9: Implement upland management practices that reduce sediment delivery to streams,
Strategy 10: Implement agricultural practices that reduce sediment delivery to streams, and

Strategy 11: Use engineering techniques to increase complexity of permanently altered habitats.

UCSRB objectives for the Okanogan subbasin specifically

Goal: Protect and Restore Salmonid Habitat in the Okanogan Subbasin

Objective 1 Protect the remaining sockeye and summer chinook spawning and rearing habitat that remains within this watershed. In particular, the summer chinook spawning habitat located in the lower Similkameen (Category 2) and in the mainstem Okanogan River between Ellisford and Riverside (Category 2) and the remaining sockeye spawning habitat that remains downstream of McIntyre Dam (Category 2).

Objective 2 Reconnect smaller tributary streams with the mainstem Okanogan River. Many of the smaller tributaries once provided thermal refuge for summer and fall migrating adults and for rearing of stream-type juvenile salmonids.

Objective 3: Establish a normative hydrograph, decrease the width: depth ratio, increase riparian coverage, and decrease sediment input will also improve the water quality, quantity and would provide for improved upstream migration and over-summer rearing conditions. Water rights should be purchased or secured through trust for increasing late-summer instream flows of tributary streams.

Statement of Fish and Wildlife Needs

Fish

- Enhance instream flows, water quality and habitat conditions to benefit resident fish populations where they are found to be impaired.
- Obtain baseline information on status of native fish communities.
- Inventory exotic fish species in the subbasin.
- Enhance survival of post-spawn (kelt) steelhead to maximize reproductive success.

Instream restoration:

- Reestablish stream flow to recover and maintain fish populations and habitat
- Address structural barriers on the Okanogan, Similkameen, and tributaries.
- Address elevated water temperatures in Okanogan River.
- Address DDT and PCB presence in the basin.
- Address elevated sediment delivery in Similkameen River and Bonaparte Creek.
- Address pool quantity and quality throughout the basin.
- Identify needs for acclimation facilities as a precursor to supplementation programs.

Floodplain and riparian

- Restore riparian and floodplain habitat in the Okanogan River and its tributaries.
- Identify and protect remaining intact riparian area and floodplain on Okanogan.

- Manage wetland areas to maintain fish, wildlife and cultural benefits
- Conduct a shoreline resource inventory for those designated in local shoreline master plans.
- Restore wetlands throughout the agricultural zone
- Establish and monitor grazing practices in uplands to protect riparian habitat.
- Habitat enhancement projects
- Noxious weed control
- Establish a facility for native plant propogation
- Protect and create wildlife migration and travel corridors

Uplands and forest

- Restore upland and forest habitat and hydrologic function throughout the basin.
- Reintroduce fire to sagebrush steppe and forests.
- Continue to restructure forest transportation system and reduce road density.
- Continue to implement updated forest management practices with the aim of restoring forest habitat and hydrologic function.
- Habitat enhancement projects
- Noxious weed control
- Establish a facility for native plant propagation
- Protect and create wildlife migration and travel corridors
- Obtain detailed distribution and description of shrub-steppe habitats with reference to dominant plant species, vegetative condition, and habitat potential.
- Evaluate shrub-steppe habitat characteristics in relation to use by shrub-steppe obligates such as sage grouse, sharp-tailed grouse, pygmy rabbits, Washington ground squirrels, and neotropical migrants.
- Evaluate shrub-steppe restoration activities in relation to wildlife potential; including activities associated with BPA, WDFW, BLM, USFWS, NRCS, and private land.
- Evaluate landscape configuration in relation to population viability for species of interest including sage grouse, sharp-tailed grouse, pygmy rabbits, Washington ground squirrels, and neotropical migrants.
- Expand shrub-steppe quantity with the aid of acquisitions, easements, and landowner incentives such as the Conservation Reserve Program.
- Restore shrub-steppe habitat with deep soils
- Reduce and prevent degradation and fragmentation of large contiguous blocks of shrub-steppe habitat
- Evaluate shrub-steppe restoration techniques
- Develop and implement shrub-steppe restoration techniques that are economically feasible over large landscapes (e.g. establishing sagebrush by seed rather than by hand-planted rooted seedlings).

Wildlife

- Improve demographic and population monitoring of deer and elk
- Continue and/or expand surveys to monitor distribution, abundance, and viability of species of interest including bats, sage grouse, sharp-tailed grouse, pygmy rabbit, Washington ground squirrel, ferruginous hawk, golden eagle, burrowing owl, neotropical birds, and reptiles and amphibians.
- Protect key roost and hibernacula habitats for bats

CTCR Stated Needs

Conduct gap analysis projects to determine the historic and current presence of wildlife species

Conduct comprehensive species inventories for each habitat type on the reservation.

Carry out habitat enhancement efforts based on identified needs.

Evaluate the performance of net traps, fish wheels, and other gear for selective, tribal ceremonial and subsistence harvest, and collection of spring Chinook, summer/fall Chinook, steelhead, and sockeye for brood stock collection, scientific research, and trap and haul over Chief Joseph Dam.

1. Determine the ability of Canadian trap nets and fish wheels to collect and sort spring Chinook, summer/fall Chinook, sockeye, and steelhead below Chief Joseph Dam, near the confluence of the Okanogan River, and in the Okanogan River.
2. Determine the effects of trap nets and fish wheels on captured and released fish.
3. Determine the suitability and acceptability of trap nets, fish wheels, and seines (Zosel Dam) for additional tribal harvest.
4. Determine the feasibility of using trap nets and fish wheels for collecting brood stock for artificial propagation programs and collecting M&E information.
5. Determine the feasibility of trap nets and fish wheels for collecting and passing summer/fall Chinook over Chief Joseph Dam.

Develop acclimation facilities for steelhead and spring Chinook at one or more sites in the Omak Creek watershed to improve survival and minimize straying.

Develop acclimation facilities for steelhead and spring Chinook at one or more sites in the Salmon Creek watershed to improve survival and minimize straying.

Develop and implement the Omak/Salmon Creek M&E Plan to quantify the performance and effects of steelhead and spring Chinook out-planting in these two watersheds.

Plan and develop acclimation facilities for 500,000 spring Chinook yearlings to implement Phase 1 of the Okanogan River Spring Chinook HGMP.

Develop and implement an M&E plan to quantify the performance and effects of the Isolated Harvest spring Chinook program in the Okanogan River, per the HGMP.

Fund the spawning, rearing and transportation of a 500,000 smolt spring Chinook Isolated Harvest program for the Okanogan sub-basin per the HGMP.

Fund the investigation and development of an efficient water market in the Okanogan sub-basin to allow for water leases, water purchases, and water conservation to improve stream flows for fisheries restoration.

Restore a natural stream channel in lower Omak Creek to protect and improve fish spawning, rearing, and passage habitat.

Determine the feasibility and cost of long-term and annual leasing, and purchase of water in the Salmon Creek watershed to provide at least passage flows in the lower reaches.

Expand the spawning distribution and abundance of summer Chinook in the Okanogan River through new acclimation facilities located near historic spawning habitats.

1. Develop an acclimation facility near Whitestone Creek to accept some of the existing, 576,000 smolt production from Similkameen Pond to disperse spawning in historic habitats.
2. Develop an acclimation facility near Riverside to accept some of the existing PUD smolt production from the mid-Columbia River to increase spawning in historic habitats.
3. Develop an acclimation facility near Omak for rearing and release of late arriving summer/fall Chinook to increase spawning in historic habitats.

Reform the Okanogan summer/fall Chinook program by propagating late arriving Chinook and acclimating for release in the mid and lower Okanogan River

Initiate the collection and spawning of steelhead returning to the Okanogan sub-basin to develop a unique population within the Upper Columbia River Steelhead ESU.

Initiate the planning and construction of facilities necessary to collect and spawn summer/fall Chinook to develop a unique population within the ESU.

Determine the existing and potential capacity of Okanogan tributary habitat (and habitat above Osoyoos Lake) for the spawning, incubation, rearing, and migration of steelhead, sockeye and spring Chinook.

Determine the success of trap & haul, spawning, incubation, emergence, and migration of summer/fall Chinook in upper Rufus Woods Reservoir from fish collected below Chief Joseph Dam.

Assess the potential of tributaries to Rufus Woods and Roosevelt lakes for spawning, rearing, migration and smolt collection of steelhead and Chinook salmon.

Determine the potential for releasing waters from the depths of Lake Osoyoos to cool the Okanogan River to aid the migration of spring Chinook and sockeye.

Determine the feasibility of rehabilitating the riparian corridor along the Okanogan River and key tributaries to improve native fish habitat and decrease water temperatures.

Determine the potential to attract and collect juvenile anadromous fish at Chief Joseph Dam.

- Assess habitat conditions and plan restoration projects in the Cameron Lake area. This area has been overgrazed, and was burned in a wildfire in 2001. The sagebrush-steppe, riparian, and wooded habitat of the subbasin support raptors, upland game birds, songbirds, woodpeckers, jackrabbits, marten, fisher, wolverine, lynx, grizzly bear, elk, moose, bighorn sheep, and more
- Conduct baseline surveys of reptile and amphibian populations. Sagebrush lizard and western toad, both federally listed, have been documented in the subbasin

UCSRB Stated Needs

- Upper Mainstem Okanogan (Mcintyre Dam To Similkameen Confluence)
- Protect habitat and flows from McIntyre Dam downstream to Osoyoos Lake.
- Manage water releases through Okanogan Fall Dam to prevent redd scour/desiccation.
- Restore floodplain function in this reach.
- Develop a normative flow pattern in this reach.
- Reduce sedimentation and nonpoint pollution in the reach and Lake Osoyoos.

Mainstem Okanogan River (Similkameen Confluence To Mouth)

- Release water from upstream dams at critical periods to aid adult sockeye salmon migration.
- Reconnect smaller tributary streams to mainstem Okanogan River through the procurement and enforcement of water rights.
- Protect and passively restore riparian habitat on the mainstem, with upstream reaches having priority.
- Implement agricultural practices that reduce sediment delivery to the river.

Similkameen River

- Protect riparian and instream habitats from Enloe Dam to the Okanogan confluence.
- Reduce impacts from roads in floodplains, and relocate where appropriate.
- Implement agricultural practices that reduce sediment delivery to the river.
- Increase knowledge base on heat loading processes in this reach.
- Clean up mine tailings in riparian areas that have connectivity to the river.

Bonaparte Creek

- Reduce impacts from roads in floodplains, and relocate where appropriate.
- Implement agricultural practices that reduce sediment delivery to the river.

Omak Creek

- Implement forest and agricultural practices that reduce sediment delivery to the river.
- Increase stream flow.
- Protect and restore riparian habitat in middle and lower reaches.

Salmon Creek

- Provide suitable instream flows for lower Salmon Creek.
- Create a stream channel morphology in lower Salmon Creek that is consistent with historical stable stream type, and raise the water table to support riparian vegetation by developing a small but effective floodplain.
- Use passive restoration for riparian areas between Conconully Reservoir and diversion dam.
- The Upper Columbia Region should have a coordinated program that informs the public about salmonid habitat needs and means to protect water resources.

Canadian Okanagan/Similkameen Subbasin Summary

Canadian Okanagon/Similkameen Subbasin Description

General Description

Subbasin Location

The Okanagan Watershed in Canada extends north from the Columbia Plateau in Washington State to the ridge of land separating the drainage basins of the Columbia and Fraser Rivers (Figure 10). The majority of the Okanagan River mainstem lies in a valley that is a long north-south trench located in the interior plateau of British Columbia. The valley is 18 kilometers wide at the northern end, and only 5 to 10 kilometers wide at the southern end. From a few miles north of Armstrong, BC, the entire valley drains south to the Columbia River. Many of the tributaries to the Okanogan River are small systems that arise in the hills that surround this valley.

The Similkameen River, which measures approximately 197 kilometers in length, is a major tributary to the Okanogan River. The Similkameen River watershed is located to the west of the Okanogan River watershed. However, while most of the Similkameen river watershed lies in Canada, the confluence of the Similkameen and Okanogan rivers lies in Washington State.

Other notable and fish bearing main tributaries to the Okanagan River include Mission Creek and Kelowna (Mill) Creek near the city of Kelowna; Vernon Creek south of the city of Winfield; Penticton Creek near the city of Penticton; Powers Creek; Trepanier Creek just north of Peachland; and Peachland Creek near the town of Peachland. The combined stream length of these main tributaries (not including the Okanagan River mainstem itself and Kelowna Creek) is approximately 227 kilometers (Powers Creek 29 kilometers; Mission Creek 74 kilometers; Peachland Creek 31 kilometers; Penticton Creek 29 kilometers; Trepanier Creek 28 kilometers; Vernon Creek 36 kilometers). There are approximately 66 kilometers of stream accessible to stream spawning kokanee, of which 19 kilometers are located on Mission Creek. In the Okanagan Basin, 95 percent of stream spawning occurs within Mission, Kelowna (Mill), Powers, Trepanier, Peachland, and Penticton Creeks.

The Kelowna (Mill) Creek watershed is located approximately 20 kilometers northeast of the city of Kelowna. The watershed is approximately 7,900 hectares and has been used historically for irrigation, recreation, and timber harvesting activities. Stream channel assessment work carried out in the Kelowna Creek watershed identified significant changes to the stream channels within this watershed, all of which appear to be the result of past logging activities. Five sites were found to require remedial work. Several surveys have been conducted on this watershed, and gravel placement has occurred to enhance spawning and egg incubation habitat. The protection of kokanee, rainbow trout, and brook trout spawning and rearing habitat should be considered the first priority of management practices in this creek.

Figure 10: Canadian Subbasin Location Map.

Mission Creek is the largest tributary of Okanagan Lake, and ranges in elevation from 342 meters at its confluence with the lake to a maximum of 2,171 meters at the summit of Little White Mountain, with 60 percent of the watershed above 1,300 meters in elevation. The watershed, which has a total of 1,157 kilometers of forestry roads throughout its borders, is 858 square kilometers in size.

Peachland and Trepanier creeks lie within two adjacent watersheds and are located on the west side of Okanagan Lake near Peachland, BC. The Peachland Creek Watershed is 14,150 hectares while the Trepanier Creek Watershed is 25,990 hectares. Trepanier Creek Watershed ranges in elevation from 342 meters at the confluence with Okanagan Lake to a maximum of 1,900 meters at Mount Gottfriedsen, with 60 percent of the watershed above 1,160 meters in elevation. There are approximately 543 kilometers of roads within the two watersheds. Both urban development and agricultural practices occur along the lower 3 kilometers of both watersheds. At the headwaters of Peachland and Trepanier Creeks is the Brenda Mine. Both watersheds are currently under forest licenses to several forestry companies.

Vernon Creek is designated as a community watershed for the Town of Winfield, BC. Several enhancement projects have occurred in the Vernon Creek watershed including the placement of gravel for the enhancement of spawning and egg incubation potential. Riprap was added at the bottom of Wood Lake Road to stabilize stream banks in this section to prevent downstream siltation and sedimentation. A Water Survey of Canada station was located on Vernon Creek in 1973 to collect data on water quality and quantity in the creek.

The Okanagan Watershed also contains several large lakes. The largest of these is Lake Okanagan, which extends approximately from the city of Vernon in the north to the city of Penticton in the south. Next in size, and downstream in order, is medium-sized Skaha Lake, followed by the small-sized Vaseux Lake. Osoyoos Lake is a medium-sized lake that straddles the Canada-U.S. border.

Climate

The Okanagan Valley is located in the rain shadow of the Coast Mountains. Moisture is precipitated on the windward side of the mountain range resulting in a moisture deficit within the valley. Air masses descending on the leeward slopes of the Coast Mountain range are warmed and become more stable, favoring potentially higher rates of evaporation and exacerbating the moisture deficit in Okanagan Valley. Mean precipitation increases to the north and with elevation. Conversely, mean daily temperature decreases to the north and upslope. The Okanagan Valley typically experiences precipitation peaks in June and in December/January.

Vegetation

The valley bottom up to an elevation of approximately 750 meters is described as an interior Douglas-fir and ponderosa pine - bunchgrass biogeoclimatic zone. The ponderosa pine zone occurs at elevations between 335 and 900 meters as a thin band on the bottoms and/or sidewalls of valleys such as the Similkameen and Okanogan watersheds. The zone in British Columbia represents the northern limits of a zone that is much more extensive in the U.S. Typically, ponderosa pine falls between the bunchgrass and interior Douglas-fir zones. At higher elevations, within the interior Douglas-fir biogeoclimatic zone, the forest is more closed and western larch, western red cedar, and lodgepole pine are found more frequently.

Cottonwood trees are also found along many of the watercourses in the lower elevations of the Okanagan Watershed. Cottonwood forests are sensitive to changes in the watershed. Where they are found on active floodplains, cottonwood forests rely on the natural cycle of flooding to replenish soil nutrients and moisture. Many streams in the interior have been diked and channeled to prevent flooding. The Okanagan River between Penticton and the U.S. border has been converted into a straight channel. Black cottonwood is very resistant to flooding and regenerates best on disturbed lands such as floodplains. The cottonwood ecosystem of the southern interior is among the rarest plant communities in the province. In the south Okanagan and Similkameen valleys, fewer than 500 hectares remain. They are important as they provide crucial habitat, especially to species that are not well adapted to living in the arid grasslands and forests that dominate this part of the province. Cottonwoods grow quickly and die relatively young. They often provide snags (standing dead trees) which are important to a variety of wildlife species. These snags may eventually fall into the stream, where they help create cover and pool habitat for fish and other aquatic creatures. In this capacity, fallen trees help to stabilize stream banks and prevent erosion and siltation of streambeds.

Soils

Within the Okanagan Basin there are four major soil types and a group of groundwater soils where natural drainage is poor. Brown soils predominate to a maximum elevation of approximately 610 m and occur as far north as Summerland. Dark brown soils occur further north within the elevation range from 344 m to 1,067 m. These soils are found on the lower slopes and in well-drained parts of the valley bottom and are ideal for orcharding. Black soils occur largely in the north Okanagan on southern exposures throughout the entire region. They are found to an elevation of 1,372 m and are associated with low soil moisture levels and grassland vegetation. The intermontane podsol soils that are predominant in the north Okanagan are of little agricultural importance.

Land Uses

Land use composition in the Okanagan watershed and the Similkameen Watershed are notably different. In the Okanagan Watershed, there is a great deal of agricultural activity throughout the valley bottom basin, and even on many of the lower slopes above the valley bottom. There is also a large amount of urban development throughout the Okanogan Basin. In many places this urban development is now occurring on former agricultural lands, and is often extending well up the lower slopes. By way of example, the city of Kelowna now contains some 100,000 people within the city limits, and is growing rapidly. Similarly, the city of Penticton has approximately 32,000 people, and the city of Vernon has some 34,000 people.

Tourism is a major activity within the Okanagan basin (Okanagan Lake is a particularly notable attraction to tourists), and the number of people in the basin noticeably increases (probably several fold) during the summer. Most potentially developable land (including many areas formerly covered by wetlands) in the basin has now been developed, and urban and agricultural development are now expanding into even marginal land and rough terrain. It is anticipated that urban development will continue to expand at a great rate in the Okanagan Basin, and to continue to be a major stress on aquatic, terrestrial, and wetland ecosystems.

Land suitable for cultivation occurs on bottomlands, benches, and terraces within the valley. The first settlers to the Okanagan Valley developed lands adjacent to creeks, lakes, and springs, which provided storage for the limited irrigation systems they built. Between 1900 and 1920, dozens of dams of varying sizes and qualities were built in the Okanagan uplands. The character of the Okanagan Basin is being altered by increased population and land use changes and demands. During the period 1971 to 1986, urban population increased by 63 percent, twice the rate of increase for B.C. as a whole. Rural population growth was also strong, increasing by 62 percent for the same time period.

The growth of the orchard industry in the semi-arid Okanagan Valley required an inexpensive supply of water available to all orchardists. Between 1860 and 1920 agriculture moved from stock raising and grain growing to intensive orcharding thus increasing demand for irrigation. This increased demand for water resulting in long, high volume, elaborate and expensive irrigation systems requiring storage, conveyance and application of water. By 1920 such a system was in place and the Okanagan fruit industry flourished.

In contrast to the Okanagan Basin, in the Similkameen Basin the agricultural and urban development is much less advanced, and is generally restricted to a few localities.

Growing populations have threatened and endangered many species and habitats in the Okanagan Valley. Only 9 percent of the natural grasslands that are native to this valley remain due to the construction of orchards, roads, and urban development. Population growth has put pressure on the agricultural land base. Census figures show that total reported farm area declined 4.6 percent in a 15-year period from 1971 to 1986; woodland declined 47 percent; and total improved farmland declined by 22 percent. Cropland, however, rose slightly from 18,639 hectares in 1971 to 19,039 in 1986.

In both watersheds there is extensive forest harvesting activity. However, in the Okanogan Watershed this activity tends to happen mainly in the higher elevations of the watershed (due to agriculture and urban development having taken over the lower elevations). In the Similkameen Watershed, timber harvesting occurs in both the valley bottoms and higher elevations.

There is ample evidence that forest practices can reduce the abundance of some vertebrates. There is also evidence that suggests most vertebrate species are linked to specific forest elements such as large snags or hardwoods. Most forest elements with which vertebrate groups are associated are altered by forest practices. Therefore, management to sustain vertebrate richness must be planned over a large enough area that a full range of these structures is considered.

Human influence in the watershed has lead to fire suppression activities for a variety of reasons. These reasons include both protection of timber resources and protection of urban developments that exist at the forest-urban interface. Fire suppression in the valley is changing the biodiversity of the ecosystem, as many of the low elevation areas are believed to originally have been fire-induced systems. In other words, previous periodic fires maintained the species composition regime. However, such fires are no longer allowed to occur, and different, non-fire-resistant species are becoming established and dominant. An example of this is a change in predominance of fire-resistant ponderosa pine to a predominance of non-fire-resistant Douglas-fir at mid elevations.

Other changes in species composition and ecosystem function are also occurring. Introduced species are becoming more common, and they often threaten many indigenous species in the valley. Livestock grazing has also had a major impact on the biodiversity of this ecosystem, as it can disturb the soils and natural vegetation and allow for invasion of weeds like knapweed. Wildlife killed each year on Okanagan roads and from poaching in the area is also impacting wildlife species. Bird populations are primarily affected by urbanization and agricultural practices, which tend to destroy riparian habitat that is breeding habitat for many birds.

Fish and Wildlife Resources

Fish and Wildlife Status

Okanagan River and Lake

Fish distribution in seven major tributaries to the Okanagan River will be addressed separately; however, it should be noted that there are other creeks in this watershed with notable importance to the fishery within this system.

The key species of current management concern in the Okanagan Basin is kokanee. This species is under so much pressure from harvesting and land use activities that it was necessary to implement a closure of the kokanee sport fishery in Okanagan Lake in 1995. Currently, kokanee are present in Okanagan Lake and within accessible tributaries to this system, but not at historic levels. Much effort has also recently been placed on protecting, managing, and enhancing kokanee habitat.

Other sport fish species found in Okanagan Lake and mainstem include anadromous salmon, steelhead, rainbow trout, largemouth bass, smallmouth bass, and yellow perch. Forage fish species include carp, chiselmouth chub, longnose sucker, mottled sculpin, northern pikeminnow (formerly northern squawfish), pumpkinseed, redside shiner, sculpins, suckers, and tench. Bull trout are not known to be in the Okanagan Watershed on the Canadian side of the border (Matthews and Cannings, pers comm.).

Anadromous sockeye have been known to spawn just above Lake Osoyoos but do not migrate further upstream due to the presence of McIntyre Dam located 1.5 miles upstream from the confluence with Lake Osoyoos. Occasionally sockeye get past McIntryre Dam and into Vaseux Lake. From there the next migration barrier is located at Okanagan Falls Dam, although it is sometimes possible to get past this dam if the stop logs are properly set. If fish do manage to pass the dam at Okanagan Falls they enter Skaha Lake. Spawning upstream of Skaha Lake is likely only in the mainstem, as the other tributaries to this lake are too small or urbanized. The mainstem above Skaha Lake is likely accessible as far as the outlet dam on Okanagan Lake. Chinook apparently can use the mainstem of the Okanagan River to access as far as McIntyre Dam. Stocked steelhead (as manifested by adipose fin clipping) have been observed as far up the Okanogan River as McIntyre Dam. However, as with sockeye, if the dam gates are set properly, steelhead may be able to gain access further upstream (Mathews, pers comm.).

General Discussion

Constraints to anadromous and resident fish, wildlife, and habitat result from many of the direct and indirect impacts within the basin; many of these impacts and their resolution have cross-border implications. Such impacts include hydroelectric facilities and their operations, water consumption, water management, urban development, infrastructure, agriculture, forestry, water quality, ground disturbances, out right habitat loss, and introduced species.

Dealing with these constraints will require both institutional and technical approaches. The complexity of the jurisdictional arrangements and differences in management objectives within the basin necessitates an extensive and comprehensive process of trans-boundary coordination between federal, state/provincial, and local governments, public utility districts, tribal entities, and other stakeholders. Many good efforts are already underway to facilitate such coordination; but such coordination is still in its infancy, and much remains to be done. The technical component will require an ecosystem-based approach; the issues are often regional and ecologically interconnected. Moreover, the requirements of each life stage must be identified and addressed. Unfortunately, at times we have incomplete data and understanding, which greatly adds to the difficulty of managing the Okanogan basin.

Fish

It is anticipated that there will be a continued loss of fish species diversity in the Canadian Montane Cordilleran Ecozone (which includes the Okanagan Basin) in the future. Urban, agricultural, forest harvest, and other land uses are expected to increase throughout the Okanagan Watershed, and to continue to exert pressure on fish and fish habitat. These pressures may be partly diminished by recent regulatory changes. These include increased enforcement of the Federal Fisheries Act, implementation of the Provincial Fish Protection Act, and municipal initiatives such as the city of Kelowna's environmental protection bylaws. Also, it is thought that legislation such as the provincial "Forest Practices Code" should assist in reducing the degree of anthropogenic impacts on aquatic environments and slow rates of degradation that occur as a result of forest harvest activities.

Global warming is expected to increase surface water temperatures in the lakes of the Okanagan Basin, to increase the length of ice-free periods, and to increase the duration of summer stratification. For rivers, groundwater temperatures will increase. The net result of these processes is an increase in water temperature of the watercourses in the Okanagan Basin. These changes would most likely result in a northward shift in fish distributions; however, this tendency is complicated by the topography of the region. The number of warmwater species in southern parts of the ecozone may increase with global warming, but the diversity of coldwater species will probably decrease.

The B.C. Conservation Data Centre (CDC) maintains a list of both globally and provincially threatened and endangered species in the Okanagan Basin. For fish, this list is provided in Table 30.

Table 30: Global and Provincial Status of "At Risk" Fish Species in the Okanagan Basin.

Common Name	Global Rank[a]	Provincial Rank[b]	Provincial List[c]
Freshwater Fish			
Mottled Sculpin	G5	S3	Blue
Bull Trout	G3	S3	Blue
Chiselmouth	G5	S3	Blue
Umatilla Dace	G4	S2	Red
Mountain Sucker	G5	S3	Blue

[a]Basic **Global Ranks** include the following: **GX** – Presumed Extinct throughout its range, **GH** – Possibly Extinct and **G1** through **G5** where **G1** is Critically Imperiled and **G5** is Secure. Additional Ranking codes include **G#G#** which is used to indicate uncertainty regarding the exact status of a taxon; **Q** denotes questionable taxonomic status; **T** reflects the status of infraspecific taxa (subspecies or varieties) and follows the species' global rank; **U** indicates a lack of available information about status or trends and the species is therefore unrankable; and a **?** which indicates that the global rank of a species has not yet been assessed.

[b]Basic **Provincial Ranks** are similar to that of the Global Ranking system but are based upon provincial species populations and are coded with an **S** (such as **SX**, **SH**, **S1** through **S5**). Provincial ranks are sometimes followed by rank qualifiers which include **B** which refers to the breeding occurrences of mobile animals; **N** which refers to the non-breeding occurrences of mobile animals; and **Z** which refers to species that occurs within the province but as a diffuse, usually moving population (for which it is difficult or impossible to map static occurrences).

[c]**Red List** candidates include any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered, or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are those that have been, or are being, evaluated for these designations.

Blue List species are any indigenous species or subspecies (taxa) considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue listed taxa are at risk, but are not Extirpated, Endangered, or Threatened.

Yellow List candidates include any indigenous species or subspecies (taxa) which is not at risk in British Columbia. The CDC tracks some Yellow listed taxa which are vulnerable during times of seasonal concentration (for example, breeding colonies).

The presence of rare fish in the Okanagan Basin means that special care must be taken when planning land use, including the operating and building of any dams or water diversions. It is also important that care be taken to not introduce fish species to non-indigenous habitats in order that the native species present are not threatened by competition.

The following is a brief discussion of one of the species of particular concern.

Umatilla Dace

Canadian populations of Umatilla dace are found in the lower Columbia, Kettle, Kootenay, and Similkameen rivers as well as in parts of the Slocan River. Umatilla dace are not found in the Okanagan system north of the Canadian-American border, although it presumably could become established if appropriate management actions are implemented. It prefers riverine habitat with cobble or stone bottom and relatively warm, productive waters. Umatilla dace is endangered in Canada due to an extremely small population size, restricted distribution, and limited available preferred habitat. Original habitat use by the Umatilla dace has been disrupted by the construction of dams within the watersheds. Conversely, rocks used in dike construction have increased available habitat. Although immediate threats to populations appear to be small, one natural process that may be dangerous is eutrophication. The excessive algae that grows during the stages of eutrophication may deter Umatilla dace, as they tend to not be found around large growths of algae.

Wildlife

The BC Conservation Data Centre list of both globally and provincially threatened and endangered species in the Okanagan Basin provided below in Table 31.

Table 31: Global and Provincial Status of “At Risk” Wildlife Species in the Okanagan Basin.

Common Name	Global Rank[a]	Provincial Rank[b]	Provincial List[c]
Amphibians			
Tailed Frog – Coastal	G4T4Q	S3S4	Blue
Tiger Salamander	G5	S2	Red
Great Basin Spadefoot	G5	S3	Blue
Northern Leopard Frog	G5	S1	Red
Reptiles			
Painted Turtle	G5	S3S4	Blue
Pigmy Short-Horned Lizard	G5	SH	Red
Rubber Boa	G5	S3S4	Blue
Racer	G5	S3S4	Blue
Gopher Snake, *deserticola* subspecies	G5T5	S3	Blue
Western Rattlesnake	G5	S3	Blue
Birds			
Western Grebe	G5	S1B,S3N	Red
American Bittern	G4	S3B,SZN	Blue
Great Blue Heron, *herodias* subspecies	G5T5	S3B, S5N	Blue
Tundra Swan	G5	S3N	Yellow
Redhead	G5	S3N, S4B	Yellow
Bald Eagle	G4	S4	Yellow
Swainson's Hawk	G5	S2B, SZN	Red
Ferruginous Hawk	G4	S1B	Red
Rough-Legged Hawk	G5	S2S3N	Yellow
Peregrine Falcon, *anatum* subspecies	G4T3	S2B, SZN	Red
Prairie Falcon	G5	S2B, SZN	Red

Common Name	Global Rank[a]	Provincial Rank[b]	Provincial List[c]
Sage Grouse	G5	SX	Red
Sharp-Tailed Grouse, *columbianus* subspecies	G4T3	S3	Blue
Sandhill Crane	G5	S3B, SZN	Blue
American Avocet	G5	S2S3B, SZN	Blue
Upland Sandpiper	G5	S1S3B, SZN	Red
Long-Billed Curlew	G5	S3B,SZN	Blue
Ring-Billed Gull	G5	S4B, SZN	Yellow
California Gull	G5	S3B,SZN	Blue
Barn Owl	G5	S3	Blue
Flammulated Owl	G4	S3S4B, SZN	Blue
Western Screech-Owl, *macfarlanei* subspecies	G5T?	S2	Red
Burrowing Owl	G4	S1B, SZN	Red
Short-Eared Owl	G5	S2N, S3B	Blue
White-Throated Swift	G5	S3S4B, SZN	Blue
Lewis's Woodpecker	G5	S3B, SZN	Blue
Williamson's Sapsucker, *thyroideus* subspecies	G5TU	S3B, SZN	Blue
White-Headed Woodpecker	G4	S1S2	Red
Gray Flycatcher	G5	S3	Blue
Canyon Wren	G5	S3	Blue
Sage Thrasher	G5	S1B	Red
Yellow-Breasted Chat	G5	S1B	Red
Brewer's Sparrow, *breweri* subspecies	G5T4	S2B	Red
Lark Sparrow	G5	S2B, SZN	Red
Grasshopper Sparrow	G5	S2B	Red
Bobolink	G5	S3B,SZN	Blue
Mammals			
Preble's Shrew	G4	S1	Red
Merriam's Shrew	G5	S1	Red
Fringed Myotis	G4G5	S2S3	Blue
Western Small-Footed Myotis	G5	S2S3	Blue
Northern Long-Eared Myotis	G4	S2S3	Blue
Spotted Bat	G4	S3	Blue
Townsend's Big-Eared Bat	G4	S2S3	Blue
Pallid Bat	G5	S1	Red
Nuttall's Cottontail	G5	S3	Blue
Mountain Beaver, *rainieri* subspecies	G5T4	S3	Blue
Cascade Golden-Mantled Ground Squirrel	G5	S3S4	Blue
Great Basin Pocket Mouse	G5	S3	Blue
Western Harvest Mouse	G5	S2S3	Blue
Fisher	G5	S3	Blue
Northern Bog Lemming, *artemisiae* subspecies	G4T2T3	S2S3	Blue
Grizzly Bear	G4	S3	Blue
Fisher	G5	S3	Blue
Wolverine, *luscus* subspecies	G4T4	S3	Blue
Badger	G5	S2	Red
Caribou, Southern population	G5T2T3Q	S2	Red
California Bighorn Sheep	G4G5T4	S2S3	Blue

[a]Basic **Global Ranks** include the following: **GX** – Presumed Extinct throughout its range, **GH** – Possibly Extinct and **G1** through **G5** where **G1** is Critically Imperiled and **G5** is Secure. Additional Ranking codes include **G#G#** which is used to indicate uncertainty regarding the exact status of a taxon; **Q** denotes questionable taxonomic status; **T** reflects the status of infraspecific taxa (subspecies or varieties) and follows

the species' global rank; **U** indicates a lack of available information about status or trends and the species is therefore unrankable; and a **?** which indicates that the global rank of a species has not yet been assessed.

[b]Basic **Provincial Ranks** are similar to that of the Global Ranking system but are based upon provincial species populations and are coded with an **S** (such as **SX**, **SH**, **S1** through **S5**). Provincial ranks are sometimes followed by rank qualifiers which include **B** which refers to the breeding occurrences of mobile animals; **N** which refers to the non-breeding occurrences of mobile animals; and **Z** which refers to species that occurs within the province but as a diffuse, usually moving population (for which it is difficult or impossible to map static occurrences).

[c]**Red List** candidates include any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered, or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are those that have been, or are being, evaluated for these designations.

Blue List species are any indigenous species or subspecies (taxa) considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue listed taxa are at risk, but are not Extirpated, Endangered, or Threatened.

Yellow List candidates include any indigenous species or subspecies (taxa) which is not at risk in British Columbia. The CDC tracks some Yellow listed taxa which are vulnerable during times of seasonal concentration (for example, breeding colonies).

The following are brief discussions of some of the species of particular concern.

Amphibians

Tiger Salamander

The tiger salamander is widespread in North America and is capable of tolerating dry conditions of many regions such as those found in the interior. Its distribution within the southern Okanagan Valley reaches as far north as Summerland and Meadow Valley and to the east, at least to Myer's Lake. Tiger salamanders are typically found near small alkaline lakes and ponds and can resist periods of drought by residing below ground. They also choose breeding sites that are adjacent to grassland foraging habitat with access to suitable alkaline lakes and ponds with prey availability.

Development of roads, agricultural lands, and housing complexes is the main limiting factor for the tiger salamanders. Trampling of lakeside habitat by livestock impacts salamander eggs or larvae and leads to soil compaction which limits opportunities to gain subterranean refuge. Overgrazing or destruction of adjacent foraging habitat and degradation of water quality by livestock activities are additional concerns. Water use for irrigation may lower water levels sufficiently to be detrimental to the salamander population. Improperly screened pumps cause mortality.

In permanent lakes, game fish and other predatory fish prey on salamander eggs and larvae. These fish have been introduced into lakes suitable for salamanders. The remaining populations in temporary ponds are subject to periodic drought.

Reptiles

Night Snake

In Canada, the night snake is only found in British Columbia. It is one of the rarest snakes in the country. This species occurs in a variety of habitats but is generally associated with arid regions, especially sandy and rocky habitats. While the habitat in which this species has been recorded in the last decade remains relatively intact, the original valley vegetation has been severely altered by humans.

Little is known about the limiting factors except that they may include competition, predation, prey availability, or human disturbance. Their nocturnal nature suggests that the night snake's main threat from humans is in terms of habitat destruction. Climate is probably an important limiting factor affecting population size and distribution. Oviparous snakes in British Columbia, and in Canada generally, have a significantly more restricted range than viviparous species.

Short-Horned Lizard

The short-horned lizard has not been positively identified in British Columbia since 1898. The species was probably never common in British Columbia and it is likely that this population was a peripheral isolate and is now extirpated from British Columbia. The short-horned lizard occurs in a variety of habitats from sagebrush deserts to light forests, and at a wide range of elevations. It is most frequently found in open habitats where the soil is loose and sandy, but may be found in rocky areas. It is quite cold tolerant, which accounts for its occurrence at high elevations and high latitudes.

Birds

Brewer’s Sparrow

There are two geographic subspecies of Brewer’s sparrow in British Columbia. The sagebrush subspecies breeds in the Okanagan and Similkameen valleys south of Penticton. The timberline subspecies migrates through the Okanogan to breed in northern British Columbia and the southern Yukon; it also breeds in the mountains of southeastern British Columbia to the international border. This is a bird of open brushlands such as sagebrush plains, alpine meadows, and valleys where low shrubbery prevails. Sagebrush in medium to high density is the preferred habitat of the sagebrush Brewer's sparrow for nesting and foraging for insects and weed seeds.

The main threat to the sparrow is the conversion of sagebrush land to other uses. Removal of sagebrush habitat to increase forage for cattle is a primary limiting factor in the distribution of the sagebrush Brewer's sparrow throughout its range in the Okanagan. As well, cattle may also damage and/or disturb nests and degrade foraging areas. Use of insecticides for insect control may harm the birds directly or through contamination or reduction of their prey species.

Burrowing Owl

Historically, burrowing owls in British Columbia bred mainly in the Okanagan-Similkameen and south Thompson basins. Since 1928, only three nest sites have been located: one at Chopaka in the lower Similkameen Valley (1943), another at Okanogan Landing (until 1963), and a third on the West Bench near Penticton (1970). Now burrowing owls are found only at reintroduction sites near Osoyoos and Kamloops. burrowing owls were designated as threatened in 1979 and were reconfirmed as threatened in 1991. In 1995 the situation was reevaluated and burrowing owls were uplisted to endangered. Except for some recent nests derived from introductions, its true breeding status is not clear, but there may still be a few isolated nesting pairs in the Okanagan Valley each year. The reintroduction of burrowing owls has not been successful in establishing a stable population.

The major habitat needs of burrowing owls are prairie-like terrain with low herbaceous vegetation, deep soil for burrows, the presence of mammals that excavate burrows, and a food supply. They are adapted to open, usually dry country with short vegetation. Being ground-dwellers, it is difficult for them to detect approaching predators or find prey in brushland or forest. They are well adapted to grazed rangelands, but find croplands less suitable. The terrain is often flat, but rugged landscapes are also used. The extent of suitable habitat is quite restricted in British Columbia.

The overall abundance of burrowing owls is limited by the availability of suitable habitat. The grasslands in which they live are restricted to the dry valley bottoms of the southern interior, and comprise less than one percent of the area of the province. Expanding towns, intensive agriculture, and a multitude of other industrial uses and developments, especially in the Okanagan Valley is further diminishing this small area of natural grassland. The burrowing owl used badger holes as burrows. When cattle were introduced to the grasslands, the badgers were killed because their holes were a hazard. Badgers probably declined as a result of over-hunting, habitat loss, and habitat fragmentation.

Sage Grouse

The sage grouse apparently was always a rare bird in the extreme south of the Okanagan and Similkameen valleys before its complete disappearance in the first quarter of the Twentieth Century. The region probably offered only marginal habitat and, being at the northern limit of its range, the sage grouse probably existed precariously.

The sage grouse is restricted to open big sagebrush habitats in the extreme south Okanagan. The strutting ground habitat is moderately open sagebrush with a canopy coverage of 20 to 50 percent. A minimum radius of 2.4 km around strutting ground is suggested for protection of habitat.

The sage grouse has been heavily impacted by reduction of range and uncontrolled hunting. The restricted range resulting from livestock grazing and agriculture has meant that there probably is not enough habitat left in British Columbia for reintroduction. Agriculture, excessive livestock grazing, and sagebrush control using herbicides and fire are primarily responsible for loss of shrub-steppe habitat. These continue to threaten sage grouse habitat in addition to irrigation projects; commercial, industrial, and power development; and military training. It has been found that reduction of sagebrush cover reduces male attendance and nest success, and broods will avoid meadows surrounded by bare ground.

White-headed Woodpecker

The British Columbia population of the white-headed woodpecker has apparently fluctuated widely over the last 50 years. The species was considered very rare in the late

1950s and early 1960s, but became more numerous in late 1960s and early 1970s. The British Columbia population was under 100 birds when last surveyed in 1990. In Canada, the white-headed woodpecker is found only in British Columbia, where it is a very rare resident in the Okanagan Valley. The white-headed woodpecker requires mature ponderosa pine stands restricting it, more or less, to the benches and hills of the Okanagan Valley below 600 or 700 m elevations. They have also been found in ornamental gardens, mixed ponderosa pine/Douglas-fir forest, Douglas-fir forest, Engelmann spruce/lodgepole pine forest, and black cottonwoods.

The primary limiting factor for populations of the white-headed woodpecker in Canada is the dependence of the species on mature to old-growth ponderosa pine forests. This dependence is likely related to both the availability of snags for nesting and roosting as well as the availability of cones for foraging. Most of the old-growth ponderosa pine forests of British Columbia were heavily logged in the 1930s and 1940s and only scattered remnants remain, usually in sites with difficult access. Seed production by ponderosa pines is also related to the age and size of the trees and the density of the stand; large, dominant trees in open situations produce almost all seeds. As a result of logging and subsequent fire suppression, many ponderosa pine forests in the Okanagan Valley are now characterized by dense stands of young trees, presumably resulting in poor seed production there. Reduced snag densities after even selective logging would likely seriously lower the quality of white-headed woodpecker nesting habitat. As well, the habit of nesting low in snags may increase nest predation pressure. Since insects are an important food source for white-headed woodpeckers, particularly in the summer, pesticide application in ponderosa pine forests would likely have a significant impact on woodpecker populations.

Yellow-breasted Chat

The yellow-breasted chat is on the British Columbia Wildlife Branch 1993 Red List of candidate species to be considered for legal designation under the British Columbia Wildlife Act as Endangered or Threatened. It is also protected under the federal Migratory Birds Convention Act of 1994 as well as the British Columbia Wildlife Act of 1982.

In British Columbia, the yellow-breasted chat is essentially restricted to the valley bottoms of the south Okanagan and Similkameen valleys from Vaseux Lake and Cawston south, where it has been long established. Almost all known territories are located along the Okanagan and Similkameen rivers rather than in side valleys. Outside that area there is only one breeding record and 15 other sight records, mostly of singing males. In the Thompson-Okanagan they are locally common in a few remaining habitat patches but rare elsewhere.

The yellow-breasted chat is a bird of edges of woods, fence rows, dense thickets, and brambles in low wet places near streams, pond edges, or swamps and in old overgrown clearings and fields. The lowland riparian thickets favored by chats are very vulnerable to clearing for agricultural and residential/industrial developments. There now seem to be only five sites remaining in the province that are suitable for breeding: the south Similkameen Valley, which probably contains the most extensive habitat in the province; Okanagan River oxbows at the north end of Osoyoos Lake; Okanagan River between Inkaneep Provincial Park and McIntyre Bluff; Vaseux Lake, primarily at the north end but previously at the south end, as well; and woodlands along the Okanogan River on the Penticton Indian Reserve. Chat territories next to farmlands, particularly orchards, might be affected by pesticide applications either indirectly (through loss of insect food) or directly (through direct contact with pesticides).

Mammals

Pallid Bat

The pallid bat is one of the rarest mammals in British Columbia and is therefore on the Provincial Red List. In British Columbia, the pallid bat is afforded complete legal protection under the Wildlife Act. All Canadian sightings have occurred in extreme southern British Columbia in the southern Okanagan Valley in a localized area between Oliver, Osoyoos, and Okanagan Falls. The southern Okanagan Basin ecosection represents the northernmost known limit of the pallid bat's distribution. The pallid bat is found in arid desert habitat in British Columbia, often near rocky outcrops and water. It is restricted to low elevations (300 to 490 meters) in sagebrush-steppe areas and ponderosa pine forests in the vicinity of cliff faces and water. Preferring to forage in open areas, the pallid bat can be found over lengthy tracts of sandy, sparsely vegetated sagebrush and grassland. Gravel roads and canyon mouths are preferred feeding areas. The ponderosa pine trees are preferred as night roosts and steep cliffs for day roosts.

It seems likely that pallid bat have always been rare in the Canadian portion of their range because of restricted habitat and a less than ideal climate and low recruitment. However, severe habitat loss in the South Okanagan has probably further limited their numbers. Colonial species are sensitive to human disturbance. Any human activity that disturbs the bats in their night roost, day roosts, or foraging grounds, could potentially cause pallid bat to move out of the area. These activities may include logging, industrial activity, hiking, and rock climbing. Habitat loss from conversion of sagebrush-steppe habitat to other uses such as housing developments and golf courses appear to be on the increase in the Okanagan. The reduction of open foraging areas because of development as well as grazing by cattle may degrade foraging areas, reducing prey diversity and density. Roost sites are generally secure because of inaccessibility, however. Pesticides are used extensively in Okanagan fruit orchards and potentially have detrimental effects on the pallid bat populations. Because of the climate in British Columbia, pallid bat may suffer more from ingesting pesticides than pallid bat farther south. Pesticides are stored in the fatty tissues and are released when the fat is metabolized. The effect of ingested pesticides is probably worst during severe cold because more fat reserves are used during hibernation and migration. In addition, pesticides and herbicides may limit the prey supply, but it is not known how this would affect the abundance of the pallid bat.

Western Harvest Mouse

Because of its limited range and apparent rarity, the western harvest mouse was placed on the provincial Blue List by the Ministry of Environment. With no evidence for population declines, the western harvest mouse does not warrant a threatened or endangered status. However, because it occurs in low population numbers, has a restricted range and low dispersal abilities, and there is evidence for habitat fragmentation, this species should remain on the provincial Blue List as a sensitive species. In British Columbia, the western harvest mouse is known only to occur in the lower elevation grasslands in the southern Okanagan and Similkameen valleys at low elevation. Across North America, the western harvest mouse inhabits sagebrush-steppe and agricultural areas below elevations of 500 m. It forages in grasslands bordering riparian areas such as irrigation rights-of-way, coastal salt marshes, streams, or lakes, and in ravines of deciduous willow, rose, and trembling aspen. In British Columbia, they are mainly associated with edge habitats bordering agricultural areas and rangeland.

Cattle grazing, agriculture, and urbanization have affected grassland habitats in southern British Columbia. The most intensive grazing in the Okanagan Valley occurred in the late 1880s. Over-grazing by cattle has altered the plant species composition and cover in British Columbia grasslands and, presumably, this has affected habitat quality and small mammal population densities. Heavy cattle grazing reduced cover in ravines and on the grasslands, causing threats to the habitat of the western harvest mouse. Grazing also reduced the availability of food, since the western harvest mouse's diet consists primarily of seeds from grasses. In British Columbia, ongoing habitat loss through urbanization has had the greatest impact on this species. Historically, grasslands were distributed continuously throughout low elevations of the Okanagan and Similkameen valleys. The conversion of grasslands to irrigated orchards, vineyards, and cultivated fields, and recent urban development has eliminated much of the original grassland-steppe in these valleys and contributed to habitat fragmentation. The rapid growth of urban centers, such as Penticton, Kelowna, and Vernon, in the past decade has resulted in significant habitat loss and contributed to fragmentation of the range. Other potential limiting factors are competition with other small mammals and habitat disturbance from hay mowing, cultivation, and fire.

White-tailed Jackrabbit

The white-tailed jackrabbit is probably extirpated in British Columbia and is therefore on the Provincial Red List. Before extirpation, this race was restricted in Canada to the southern Okanagan and Similkameen valleys of British Columbia. Where it is at the northern periphery of its range in British Columbia, it is probably extinct. The white-tailed jackrabbit uses different habitat types seasonally.

The white-tailed jackrabbit probably disappeared in British Columbia as a result of over-hunting, habitat loss, and habitat fragmentation. The white-tailed jackrabbit used to be locally abundant, but numbers were reduced because of cultivation and extermination by farmers who viewed them as pests and sources of fur. One reason that they are limited by any development of their habitat is that they require a large home range, estimated to be as large as 89.4 hectares in Colorado. Consequently, their numbers have dropped due to the reduction of available habitat. Since they can cause agricultural damage, the white-tailed jackrabbit is not considered adaptable to human disturbance. Grazing of rangelands by cattle may result in Jackrabbits no longer using the area since there is about a 50 percent overlap between the diets of cattle and jackrabbits. Severe winter conditions increase mortality and may reduce reproduction the following spring as well as cause the Jackrabbits to be more susceptible to predators if the snow cover is scarce. Wet weather also increases juvenile mortality. As well as contending with a number of large predators, the white-tailed jackrabbit populations are controlled by diseases and parasites of several kinds, including tularaemia, Colorado tick fever, equine encephalitis, and fever caused by heavy infestations of botfly larvae.

Habitat Areas and Quality

Streams flowing into the Okanagan mainstem show high nutrient (nitrogen and phosphorus) loading, most of which is not immediately available for plant or algal growth. The rate of supply of nutrients that are available to plants and algae for growth appears to be the limiting factor for overall biological production in the Okanagan mainstem lakes. In larger, deeper lakes such as Okanagan Lake, oxygen tends to remain plentiful and is therefore thought to not be a limiting factor.

The following sections detail the areas of the subbasin in further detail.

Chute Creek

Flowing from the east, Chute Creek drains directly to Okanagan Lake.

Known fish species in the system include brook trout, kokanee, and rainbow trout. Summerland and Pennask Lake Hatcheries have also stocked Chute Creek with rainbow trout at the eyed egg life cycle stage.

Table 32: Chute Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 200m u/s		
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	DG		
Large Woody Debris	DG		
Percent Pool	P1		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1		
Stream Flow			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 200m u/s		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	DG		
Floodplain Connectivity	P1		

This system is extremely precipitous in the lower reaches thus limiting fish access further upstream. The steep nature of Chute Creek reduces the potential for rearing pool formation in addition to increasing potential washout of spawning gravel and large woody debris.

In response to this high stream energy and erosion potential, the lower 200 m of Chute Creek have been confined in a concrete flume as a flood control measure. The flume has effectively eliminated any possibility of restoring even a low level of salmonid production in lower Chute Creek.

A diversion dam located 17.3 m upstream of the confluence represents a potential barrier to further upstream migration by resident fish populations. There is also a cascade located approximately 430 m upstream of the confluence that would also restrict fish passage.

Projects Undertaken

Fish and fish habitat projects undertaken in the watershed include:

Project Name: Nicola/Similkameen/Okanagan River Reconnaissance (1:20 000) Fish and Fish Habitat Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to RIC standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-99 End date:
Location(s): Main Stem + Tributaries; Chute Creek (including tributaries Nuttall/Ratnip Creeks), tributary to Okanagan Lake/Okanagan/Columbia Rivers, near Naramata.

Eneas Creek

Eneas Creek is a third order stream that measures 19 km in length. The stream flows from the headwaters at Garnet Valley Dam and Reservoir, located about 14.5 km upstream. The confluence is located on Okanagan Lake just north of the town of Summerland, BC.

Brook trout, kokanee, rainbow trout and Redside Shiner are known to be present in Eneas Creek. The reach downstream of the Reservoir to the Highway 97 crossing, a distance of approximately 13 km, supports a substantial population of Eastern Brook Char, as does the Reservoir itself. In addition, fish stocking of rainbow trout as either eyed eggs or fry has occurred by Summerland and Pennask Lake Hatcheries.

Table 33: Eneas Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 0.5km u/s	U/s of 0.5km	
Water Quality			
Dissolved Oxygen	DG	DG	
Stream Temperature	DG	G1	
Turbidity/Suspended Sediment	P1	G1	
Nutrient Loading	P1	G1	
In Channel Habitat			
Fine Sediment (substrate)	DG	DG	
Large Woody Debris	DG	DG	
Percent Pool	DG	DG	
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1	DG	
Stream Flow			
Resembles Natural Hydrograph	P1	DG	
Impervious Surface	DG	DG	
Stream Corridor			
Riparian Vegetation	DG	DG	
Stream Bank Stability	DG	DG	
Floodplain Connectivity	DG	DG	

Less than 0.6 km of the lower reach of the stream is likely accessible to adult rainbow trout and kokanee from Okanagan Lake, owing to a series of difficult culvert obstructions. Despite access restrictions and some deterioration in water quality below Summerland, trout and kokanee production remains viable.

A fish kill in 1989 was the combined result of low stream flows and streamside pesticide applications.

A small groundwater tributary enters Eneas Creek about 0.5 km upstream of the confluence with Okanagan Lake. According to a local resident this stream has supported spawning by up to "8 pairs of trout and 135 kokanee" in years past. Water quality was apparently exceptionally good in this tributary.

Projects Undertaken

An incubation box was used for several years to enhance kokanee escapement in Eneas Creek. Gravel placement and cleaning took place in an effort to enhance spawning and egg incubation habitat.

There is an opportunity to view spawning kokanee on Eneas Creek that could be further developed for educational purposes. Very few areas for the enhancement of kokanee remain and should be preserved.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Trout & Eneas Creek Watershed Restoration
Description: The Trout Creek watershed drains the Thompson Plateau on the west side of Okanagan Lake near Summerland. The watershed is 744 sq. km in size and ranges from 342 m to 1920 m.
Objective: This watershed will be assessed to determine what work will need to be completed in order to restore the areas that were damaged by past activities, such as logging.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: District of Summerland
Activity: Restoration - Overview Assessment
Description: For this activity an Integrated Watershed Restoration Plan was conducted. The objectives were defined and a summary of findings and recommendations were issued. It contains a Fish Habitat Assessment Procedure, Sediment Source Survey and Access Management Map.
Comment: Report Title: Trout and Eneas Creek Integrated Watershed Restoration Plan
Percentage of Work Completed: None Informal Monitoring in Progress
Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Eneas Creek, tributary to Okanagan Lake. Located ~20-30 km North of Penticton.

Equesis Creek

Equesis Creek is a fourth order stream that measures 23.3 km in length. It flows from the headwaters of Pinaus Lake east into the northwest arm of Okanagan Lake. The confluence is located about 9.6 km west of Vernon, BC.

Fish species known to be present in this system include kokanee, rainbow trout, and yellow perch.

Table 34: Equesis Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	P2		
Nutrient Loading	DG		
In Channel Habitat			

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Fine Sediment (substrate)	P1		
Large Woody Debris	DG		
Percent Pool	DG		
$\leq$ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1		
Stream Flow			
Resembles Natural Hydrograph	F1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	DG		
Floodplain Connectivity	DG		

The lower 13 km of Equesis Creek are thought to be productive. However, persistent organic debris in the system is blocking the creek and restricting fish migration into this reach. Several small dams located on Equesis Creek also limit fish passage to upper reaches.

An earth dam was constructed to stop yellow perch migration, and several other diversion irrigation dams further upstream also restrict other fish migration. An irrigation dam located 2.6 km upstream of the confluence with Okanagan Lake is likely passable to larger trout in the spring, but is impassable to kokanee in the fall. Apparently this dam was originally designed to pass fish, but accommodation for fish passage during installation was not made. An irrigation dam situated approximately 3.7 km upstream of the confluence with Okanagan Lake likely limits further upstream trout migration except during certain conditions such as spring freshet. The dam appears to have been designed and installed with no special provision for fish passage. These obstructions in the lower reaches may have seriously reduced the level of trout and kokanee recruitment to Okanagan Lake from the creek.

It is noteworthy that Pinaus Lake, located at the headwaters of Equesis Creek, does support an intensive trout fishery.

Habitat quality varies considerably over the entire length of the system. However, it appears much of the stream is capable of producing and supporting trout in the presence of adequate flows during late summer and early fall. Stable winter discharge is also necessary to sustain overwintering trout juveniles and incubating kokanee eggs. Additional reservoir storage would make a big difference in the ability of the system to meet total annual water use higher than this level.

Projects Undertaken

A fishway present on Equesis Creek was modified and reconstructed in 1990 to allow for rainbow trout access to upper reaches.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Equesis/Naswhito/Whiteman Creek Fish Habitat and Passage Assessments
Description: Habitat assessment for approx. 8km.
Project Status: Active **Start Date:** 22-NOV-99 **End Date:** 31-MAR-00
Lead Proponent: Okanagan Nation Fisheries Commission
Activity: Assessment - Habitat Assessment
Description: Assessment of the quality of fish habitat and the diversion structures for ease of fish passage, according to Level 1 fish and fish habitat assessment methods.
Activity Term: Start date: 22-NOV-99 End date: 31-MAR-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Equesis Creek tributary to Okanagan Lake/Okanagan/Columbia River near Vernon.

Project Name: Naswhito Creek Watershed Restoration
Description: The Naswhito Creek watershed is a tributary to Okanagan Lake situated approximately 20km west of Vernon. The watershed area is approximately 80 sq. km.
Objective: The objectives of this project are to restore the watershed to some level of pre harvest condition, to restore natural hydrology to the area, and to enhance and rehabilitate riparian habitat. Specific actions undertaken may be road deactivation, gully and landslide rehabilitation and sediment source detection.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Riverside Forest Products Limited
Activity: Restoration - Overview Assessment
Description: This activity report outlines the overview fish habitat assessment procedure conducted for the Equesis, Naswhito, Whiteman and Shorts watersheds. The objective of this report was to assess the present condition of watersheds by reviewing historical fish studies, forest harvesting, water quality and discharge, maps and airphotos. The watersheds are located on the west side of Okanagan Lake, west of Vernon, BC
Comment: Report Title: Overview Fish Habitat Assessment Procedure: Equesis, Naswhito, Whiteman and Shorts watersheds Percentage of Work Completed: N/A
Activity Term: Start date: 25-APR-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Equesis Watershed is located north of Naswhito Creek (20km west of Vernon) and drains into the west side of Okanagan Lake. It is a main tributary of the Okanagan River. Equesis Creek WSC: 310-966900.

Inkaneep Creek

Inkaneep Creek measures 23.5 km in length and flows adjacent to reserve land.

Known fish populations within this stream include brook trout and rainbow trout. Fish access is limited to the lower 3 km.

Table 35: Inkaneep Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 3km u/s	Falls at 3km u/s of confluence	
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	P2		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	DG		
Large Woody Debris	F2		
Percent Pool	DG		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	DG		
Stream Flow			
Resembles Natural Hydrograph	DG		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	P2		
Floodplain Connectivity	G2		

Several falls located on Inkaneep Creek restrict fish passage upstream of these barriers. There is a 23 percent gradient over 11 m with fast water and a 5.8 m high falls further upstream.

Forestry and agriculture in the area have contributed to the degradation of spawning habitat in the lower reaches. Agricultural related clearing to the streambanks in the lower and some upper reaches has exacerbated the situation.

A road related slide located on Gregoire Creek has contributed significant bedload to Inkaneep Creek.

Streambank stability in the lower reaches is considered poor. Flood events and deposition are changing the direction of the stream.

Kelowna (Mill) Creek

Kelowna (Mill) Creek is a fourth order stream. It flows through the city of Kelowna, BC where it drains directly to Okanagan Lake. Urban development, particularly in the lower reaches of Kelowna Creek, has heavily influenced and placed a strain on the fish populations within this creek.

Fish presence in Kelowna Creek includes brook trout, kokanee, largescale sucker, prickly sculpin, rainbow trout, and redside shiner. Brook trout fry and fingerling have been stocked in Kelowna Creek by the Summerland Hatchery.

Table 36: Kelowna Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to gradient increase		
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	P2		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	P1		
Large Woody Debris	DG		
Percent Pool	DG		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	G1		
Stream Flow			
Resembles Natural Hydrograph	F1		
Impervious Surface	P1		
Stream Corridor			
Riparian Vegetation	P1		
Stream Bank Stability	DG		
Floodplain Connectivity	DG		

By virtue of intensive streamside development, particularly in the lower 4 km, water quality and productive salmonid habitat have drastically deteriorated. For this reason it is suspected the stream is at best only marginally productive for trout and kokanee. Eutrophication of gravel substrate has occurred, limiting spawning and egg incubation habitat. In the past, high suspended solid loads were observed during the kokanee spawning period. Apparently these suspended solids emanated from a storm drain cleaning program.

One of the few production assets of Kelowna Creek is its relatively stable discharge regime. Specific amounts of water are being released from the dam located at the outlet of Postill Lake to promote rapid flushing of lower stream pollutants. This release may be having the inadvertent benefit of perpetuating the small populations of trout and kokanee remaining in the system. Failing restoration of flushing flows, artificial cleaning of natural and artificial spawning gravel could be initiated on an annual basis.

The city of Kelowna has recently expressed interest in incorporating fisheries needs (spawning gravel additions, settling ponds, and/or children's fishing ponds) into their planning for parks and other developments.

The dam located at the outlet of Postill Lake provides water storage for the city of Kelowna. Otherwise, no known single obstruction was considered impassable to trout and/or kokanee. Rapidly increasing stream gradient northeast of the Kelowna Airport could abruptly end all upstream migration.

Projects Undertaken

Several surveys have been conducted on this watershed, and gravel placement has occurred to enhance spawning and egg incubation habitat. The protection of kokanee, rainbow trout, and brook trout spawning and rearing habitat should be considered the foremost priority to management of this creek.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Kelowna Creek Watershed Restoration
Description: Forest Renewal BC (FRBC) has funded the restoration of the Kelowna Creek Watershed which is located approximately 20 km NE of the City of Kelowna. The area is approx. 7900 ha and has been used historically for irrigation, recreation and timber harvesting. This was a joint project and the Vernon District office has the same report with a different number. In Vernon it is FRBC project #KA34-96-006. Also includes FRBC project #TOM98242.
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and mineral extraction activities.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Glenmore-Ellison Improvement District
Activity: Restoration - Overview Assessment
Description: This is an extremely large activity that includes 7 different sub activities. They are a Level I Interior Watershed Assessment Procedure (IWAP), Summary report for Level I Road Assessment in Kelowna Creek, Postill Lake Road- Preliminary Level II Rehabilitation Plan, Results of Gully Assessment Procedure, Results of Channel Assessment Procedure and Results of Riparian Vegetation Assessment.
Comment: Report Title: Kelowna Creek Watershed- Results of the Watershed Restoration Project Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-MAR-96 End date:
Habitat(s): Upslope
Location(s): Watershed; Kelowna Creek, tributary to the Okanagan River. Located just West of Kelowna.
Activity: Restoration - Overview Assessment
Description: This activity contains an Access Management Strategy for the Kelowna Creek Watershed. The objectives and methodology were explained at a public viewing and recommendations for access management were made in a later report. A special section dealt with Postill Lake Road (the main road in the drainage). It has drainage assessments and recommended improvements for the road.

Comment: Report Title: Kelowna Creek Watershed Access Management Strategy Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-JUN-96 End date:
Habitat(s): Upslope
Location(s): Watershed; Kelowna Creek, tributary to the Okanagan River. Located just West of Kelowna.

Project Name: Kelowna (Mill) Creek Watershed Restoration
Description: Part of Forest Renewal British Columbia's Watershed Restoration Program, the Kelowna (Mill) Creek watershed is located approximately 20 km northeast of the city of Kelowna, BC The watershed area is approximately 7,900 ha. The watershed has been used historically for irrigation, recreation, and timber harvesting. The Kelowna Creek watershed has been divided into 5 sub-units: Bulman, Conroy, Postill, South, and Residual. Mill Creek is now the official name for Kelowna Creek.
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and road construction.
Project Status: Active **Start Date:** 01-APR-95
Lead Proponent: Glenmore-Ellison Improvement District
Activity: Restoration - Overview Assessment
Description: Within this watershed assessment, the following tasks were identified: - update Equivalent Clearcut Area (ECA) calculations; - update the watershed report card; - provide a risk assessment of the potential hydrologic impacts associated with the proposed forest development for the period of 1998 to 2003 and; - initial and final Watershed Assessment Committee (WAC) meetings to discuss and make recommendations for the proposed forest development plans.
Comment: Report Title: Kelowna (Mill) Creek: Interior Watershed Assessment Percentage of Work Completed: N/A
Activity Term: Start date: 01-DEC-98 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; The Kelowna (Mill) Creek watershed is located approximately 20 km northeast of the city of Kelowna, BC Kelowna Creek is a main tributary of OKANAGAN RIVER. Kelowna Creek WSC: 310-808200
Activity: Restoration - Overview Assessment
Description: The intent of the Access Management Strategy (AMS) is to propose management strategies for existing and proposed roads within the entire watershed. Options to be considered will include: - ongoing maintenance for continued use and; - deactivation measures ranging from temporary to permanent with full rehabilitation to leaving the road as is, if stable.
Comment: Report Title: Kelowna Creek: Access Management Strategy Percentage of Work Completed: N/A
Activity Term: Start date: 28-OCT-96 End date:
Habitat(s): Upslope
Location(s): Watershed; The Kelowna (Mill) Creek watershed is located approximately 20 km northeast of the city of Kelowna, BC Kelowna Creek is a main tributary of OKANAGAN RIVER. Kelowna Creek WSC: 310-808200
Activity: Restoration - Overview Assessment
Description: This activity consisted of stream channel assessment work carried out in the Kelowna Creek watershed. The purpose of the channel assessment procedure was to identify significant changes to stream channels that appear to be the result of past logging activities. A total of 10 sites were assessed in the 1995/96 field seasons. Five sites were found to be requiring remedial work.

Comment: Report Title: Kelowna Creek: Results of Channel Assessment Procedure and Riparian Vegetation Assessment Percentage of Work Completed: N/A
Activity Term: Start date: 01-JUN-97 End date:
Habitat(s): Riparian, Stream
Location(s): Watershed; The Kelowna Creek watershed is located approximately 20 km northeast of the city of Kelowna, BC Kelowna Creek is a main tributary of OKANAGAN RIVER. Kelowna Creek WSC: 310-808200
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This activity consisted of Level II Road Assessments carried out for selected roads and hillslopes identified as having high priority hazards within the Kelowna Creek Watershed. A total of 10 roads were assessed in October, 1996, nine of which require remedial work which could be completed in November, 1996, if conditions are appropriate. The prescriptions for the nine roads in this report should be considered temporary due to the presence of snow at the time of inspection.
Comment: Report Title: Kelowna Creek: Level II Road Assessment for selected roads Percentage of Work Completed: Uncertain
Activity Term: Start date: 01-NOV-96 End date:
Habitat(s): Upslope
Location(s): Watershed; The Kelowna Creek watershed is located approximately 20 km northeast of the city of Kelowna, BC Kelowna Creek is a main tributary of OKANAGAN RIVER. Kelowna Creek WSC: 310-808200
Activity: Restoration - Other
Description: This activity consisted of a reconnaissance survey undertaken by Tolko Industries Ltd. to relocate sections of the Postill Lake / Kelowna Creek Road to minimize adverse road sections and debris deposition from road maintenance into Kelowna Creek. The report focuses only on the sections of road to be relocated. An additional report under separate cover is also available which provides field notes as well as site and aerial photos.
Comment: Report Title: Kelowna Creek: Postill Road Relocation Percentage of Work Completed: 76-99 percent Scheduled to finish in Spring 2000
Activity Term: Start date: 01-AUG-97 End date:
Habitat(s): Upslope
Location(s): Watershed; The Kelowna Creek watershed is located approximately 20 km northeast of the city of Kelowna, BC Kelowna Creek is a main tributary of OKANAGAN RIVER. Kelowna Creek WSC: 310-808200
Activity: Restoration - Effectiveness Monitoring & Evaluation
Description: This activity consisted of the collection of water quality data in 1995 from the Kelowna Creek watershed. The water quality monitoring portion of this Watershed Restoration Project was conducted between April 5, 1995 and August 30, 1995. Samples were taken at 11 sites and each sample was tested for ten parameters. The monitoring program will provide data to assist with determining the impacts of timber harvesting on water quality and to evaluate the effectiveness of any remedial work undertaken.
Comment: Report Title: Kelowna Creek: Water Quality Monitoring Percentage of Work Completed: N/A
Activity Term: Start date: 08-FEB-96 End date:
Habitat(s): Stream
Location(s): Watershed; The Kelowna Creek watershed is located approximately 20 km northeast of the city of Kelowna, BC Kelowna Creek is a main tributary of OKANAGAN RIVER. Kelowna Creek WSC: 310-808200
Activity: Restoration - Upslope Restoration / Rehabilitation

Description: This activity consisted of a summary of the work completed in the Kelowna Creek Watershed. The components of the Kelowna Creek watershed assessment are: - Level I Watershed Assessment; - Level I Road Condition Assessment; - Level II Road Assessment and; - Gully Assessment.
Comment: Report Title: Kelowna Creek: Results of the Watershed Restoration Project Percentage works completed is: Uncertain
Activity Term: Start date: 01-MAR-96 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; The Kelowna Creek watershed is located approximately 20 km northeast of the city of Kelowna, BC Kelowna Creek is a main tributary of OKANAGAN RIVER. Kelowna Creek WSC: 310-808200

Project Name: Kelowna Creek Watershed Restoration Plan (WRP)
Description: Kelowna Creek watershed is located approximately 20 km NE of the City of Kelowna. The area is approx. 7900 ha and has been used historically for irrigation, recreation and timber harvesting.
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and mineral extraction activities.
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: Riverside Forest Products Limited
Activity: Restoration - Overview Assessment
Description: This report contains an introduction, methods, current watershed conditions, risks of future development, conclusions, and recommendations. There is a map of the area.
Comment: Report Title: Interior Watershed Assessment for the Kelowna (Mill) Creek Watershed Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-DEC-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Kelowna Creek, tributary to the Okanagan Lake, is located approximately 20 km NE of the City of Kelowna. WSC Kelowna Creek: 310-808200

Project Name: Lower Mill Creek Watershed Restoration Project
Description: Habitat Restoration; 450 m of streambank stabilized, 450 m of instream complexing and 1400 m of riparian planting. Education; project open houses for public and senior staff and two newspaper articles published.
Project Status: Active **Start Date:** 01-AUG-99 **End Date:** 15-OCT-99
Lead Proponent: City of Kelowna
Activity: Restoration - Instream Restoration / Rehabilitation
Activity Term: Start date: 01-AUG-99 End date: 15-OCT-99
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Kelowna Creek (alias Mill Creek), tributary to Postill Lake/Thompson/Fraser River watershed near Kelowna.
Activity: Restoration - Instream Restoration / Rehabilitation
Activity Term: Start date: 01-AUG-99 End date: 15-OCT-99
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Kelowna Creek (alias Mill Creek), tributary to Postill Lake/Thompson/Fraser River watershed near Kelowna.

Project Name: Snehumption Creek- Fish Absence/Presence Inventory and Preliminary Habitat Assessment
Description: Completion of a fish absence/presence site reconnaissance inventory in the lower reaches of Snehumption Creek for purposes of gathering baseline data.
Project Status: Active **Start Date:** 01-AUG-99 **End Date:** 31-JAN-00
Lead Proponent: Lower Similkameen Indian Band
Activity: Assessment - Habitat Assessment
Description: Approx. 4 km of stream treated. Report completed of fish inventory and preliminary habitat assessment.
Activity Term: Start date: 01-AUG-99 End date: 31-JAN-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Snehumption creek tributary to Chopaka Creek/Similkameen/Okanagan River near Osoyoos.
Activity: Assessment - Habitat Assessment
Description: Approx. 4 km of stream treated. Report completed of fish inventory and preliminary habitat assessment.
Activity Term: Start date: 01-AUG-99 End date: 31-JAN-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Snehumption creek tributary to Chopaka Creek/Similkameen/Okanagan River near Osoyoos.

Project Name: Mill Creek Interpretive Signage
Description: Education/public awareness; installation of four interpretive signs.
Project Status: Active **Start Date:** 31-OCT-99 **End Date:** 31-MAR-00
Lead Proponent: City of Kelowna
Activity: Other - General
Description: Installation of four interpretive signs.
Activity Term: Start date: 01-OCT-99 End date: 31-MAR-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Kelowna Creek (alias Mill Creek), tributary to Okanagan Lake/Okanagan/Columbia Rivers, near Westbank.

Project Name: Kelowna/McDougall/Vernon Creeks Urban Referral Compliance Evaluation
Description: Review of Water Act compliance and applications for 4 urban creeks.
Objective: Ensure that streams and riparian corridors in urban areas function properly and provide habitat for wild fish species.
Project Status: Active **Start Date:** 01-FEB-00 **End Date:** 31-MAR-00
Lead Proponent: Penticton Indian Band/Columbia Environmental Consulting
Activity: Inventory - Urban
Description: 4 urban creeks reviewed for the level of compliance to the Water Act for all approved and non-approved works in and about the streams.
Activity Term: Start date: 01-FEB-99 End date: 31-MAR-00
Habitat(s): Riparian, Stream
Location(s): Main Stem of Stream; Kelowna Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.
Activity: Inventory - Urban
Description: 4 urban creeks reviewed for the level of compliance to the Water Act for all approved and non-approved works in and about the streams.
Activity Term: Start date: 01-FEB-99 End date: 31-MAR-00

Habitat(s): Riparian, Stream
Location(s): Main Stem of Stream; Kelowna Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.

Project Name: Okanagan Storm Drain Marking (88)
Description: Implementation of a Storm Drain Marking program in the Okanagan: Coordination of school groups and volunteers, marking of storm drains, and distribution of pamphlets.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other **-** General
Description: Implementation of a Storm Drain Marking program in the Okanagan: coordination of school groups and volunteers, marking of storm drains, and distribution of pamphlets.
Activity Term: Start date: 01-APR-88 End date:
Location(s): Point; City of Kelowna, Okanagan region.

Project Name: Kelowna (Mill) Creek Enhancement
Description: Planning and identification of potential enhancement projects for spawning habitat with public involvement, following the construction of a flood control project.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Restoration **-** Assessment & Planning
Description: Planning and identification of potential enhancement projects for spawning habitat.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Kelowna Creek (alias Mill Creek), tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Kelowna.

Lambly Creek

Lambly Creek flows from the west to the east, and discharges into Okanagan Lake. The confluence is located approximately 6.4 km north of Siwash Point. This fourth order stream is 23 km in length.

Fish species present in the system include kokanee, rainbow trout, longnose sucker, and other suckers. Stocking of Lambly Creek with eyed egg rainbow trout was conducted by Beaver Lake and Summerland Hatcheries.

Table 37: Lambly Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 1.2km u/s	30m Vertical Obstruction at 1.2km u/s	
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	F1		
Large Woody Debris	DG		
Percent Pool	F1		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1		
Stream Flow			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	DG		
Floodplain Connectivity	DG		

Historically this stream was reputed to be an important trout producer, although only approximately 1.5 km is accessible to migrating fish populations. A large impassable obstruction, namely a 30 m vertical falls, prevents further upstream passage.

This stream has apparently experienced severe stock size reductions. These reductions are attributed to minimal summer and fall flows that result from an almost complete water diversion at a point just over 4.8 km upstream of the confluence with Okanagan Lake. At this location a diversion dam redirects Lambly Creek flow south to the Rose Valley Reservoir. Apparently no requirement was stipulated in the original water license to provide minimum fish maintenance flows downstream. A study indicated that there should be adequate flows to meet both the Lakeview Irrigation District diversion requirements and fish flows. Establishment of upstream storage in Terrace Meadows would significantly improve flows for both kokanee and trout.

It should be noted that Lambly Creek historically has experienced natural low flows, particularly during August. This condition is only exacerbated by the presence of the

Rose Valley Reservoir Dam. Habitat qualities downstream of the falls remain compatible with some trout production. However, given the lack of suitably sized gravel in the lower reaches of this stream, establishing some flood-protected spawning refuges may improve recruitment to Okanagan Lake.

Projects Undertaken

A management plan exists for the Lambly Creek watershed to protect and manage wild fish stocks and habitat. The kokanee spawning grounds in this creek are considered sensitive and it is important to protect these areas.

Fish and fish habitat projects undertaken in the watershed include:

Project Name: Lambly Creek Watershed Restoration
Description: The Lambly Creek watershed is a community watershed located on the west shore of Okanagan Lake northwest of Kelowna. Elevation ranges from 324 m to 1800 m. Dams regulate flow into Lambly Creek. Its area is approx. 24410 ha. Access into the watershed is excellent.
Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.
Project Status: Active **Start Date:** 01-APR-97
Lead Proponent: Riverside Forest Products Limited
Activity: Restoration - Overview Assessment
Description: An Integrated Watershed Restoration Plan (IWRP) was conducted on the Lambly Creek Watershed. The activity report includes: Introduction, types of overview assessments conducted, summary of existing watershed conditions, prescription phase of the IWRP, significant problems requiring prescription work, project priorities, time and cost estimates, and recommendations. Appendices include timing of prescription work and overview maps.
Comment: Report Title: Integrated Watershed Restoration Plan (IWRP) for Lambly Creek Watershed (Vol. 1 of 5) Percentage of Work Completed: Uncertain Informal Monitoring in Progress
Activity Term: Start date: 01-DEC-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Lambly Creek flows from the northwest into Okanagan Lake just northwest of Kelowna, BC across the Lake. Lambly WSC: 310-822600
Activity: Restoration - Overview Assessment
Description: An Interior Watershed Assessment Procedure (IWAP) was conducted within the Lambly Creek Watershed. The activity report includes: Introduction, methods, watershed characteristics, results of office analysis, results of field assessment, and recommendations. Appendices include: Maps, watershed assessment procedure details, IWAP report cards, IWAP Forms 1-9, and roundtable meeting minutes.
Comment: Report Title: Interior Watershed Assessment for Lambly Creek Watershed (Vol. 5 of 5) Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-DEC-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Lambly Creek flows from the northwest into Okanagan Lake just northwest of Kelowna, BC across the Lake. Lambly WSC: 310-822600 Lambly WSC: 310-822600
Activity: Restoration - Overview Assessment

Description: This is an Access Management Strategy for Lambly Creek Watershed. The activity report includes: Introduction, overview, objectives, methodology, results, and conclusions. Appendices include: Definition of Road Deactivation Levels, Stakeholders and Resource Users Contact lists and Comments, Land Tenure and Permits Status List, and Maps.
Comment: Report Title: Access Management Strategy (AMS) for Lambly Creek Watershed (Vol. 3 of 5) Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-DEC-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Lambly Creek flows from the northwest into Okanagan Lake just northwest of Kelowna, BC across the Lake. Lambly WSC: 310-822600 Lambly WSC: 310-822600
Activity: Restoration - Overview Assessment
Description: A Fish Habitat Assessment Procedure was conducted on the Lambly Creek Watershed. The activity report includes: Introduction, materials, methodology, results and discussion (Fish Habitat Assessment and Fish Distribution Assessment), and recommendations. Appendices include: Fish Distribution Summary Form, Habitat Condition Data Form, Preliminary Habitat Assessment Form and Maps.
Comment: Report Title: Lambly Creek Watershed Fisheries Habitat Assessment Procedure (FHAP) Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-OCT-96 End date:
Habitat(s): Stream
Location(s): Watershed; Lambly Creek flows from the northwest into Okanagan Lake just northwest of Kelowna, BC across the Lake. Lambly WSC: 310-822600 Lambly WSC: 310-822600
Activity: Restoration - Overview Assessment
Description: A Sediment Source Survey was conducted within the Lambly Creek Watershed. The activity report includes: Introduction, objectives, methodology, assessment results, planning and scheduling for prescription phase, conclusions and recommendations. Appendices include: Combined Tables 1 to 5, photo documentation and maps. Some recommendations were: complete field prescriptions and remedial work for the high risk road sections as well as at approx. 200 stream crossings and to initiate an assessment of the gully as soon as possible.
Comment: Report Title: Sediment Source Survey Report for Lambly Creek Watershed (Vol. 2 of 5) Percentage of Work Completed: N/A Works done in 1998 and 1999 and some informal monitoring in progress
Activity Term: Start date: 01-DEC-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Lambly Creek flows from the northwest into Okanagan Lake just northwest of Kelowna, BC across the Lake. Lambly WSC: 310-822600 Lambly WSC: 310-822600
Activity: Restoration - Overview Assessment
Description: These are the final Watershed Assessment Committee (WAC) recommendations. The objective of this report is to provide information regarding both the current watershed condition and the risks associated with proposed forest development. The report includes: Introduction, watershed characteristics, methods, results of office analysis, results of field assessment, risk of future forest development, conclusions and recommendations. Appendices include: Watershed Assessment Plan requirements, Re-Cap Procedure Details, Maps, Peak Flow analysis, longitudinal profiles for Lambly watershed and Re-Cap office and field forms.
Comment: Report Title: Interior Watershed Assessment Procedure (IWAP) for Lambly Creek Watershed (Update Report) Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-NOV-98 End date:
Habitat(s): Upslope

Location(s): Watershed; Lambly Creek flows from the northwest into Okanagan Lake just northwest of Kelowna, BC across the Lake. Lambly WSC: 310-822600.

Project Name: Tadpole Lake Water Storage
Description: Collection of information and development of a plan for sharing water storage in Tadpole Lake with Westbank Irrigation District to secure minimum flow for Powers Creek.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other - General
Description: Collection of information and development of a plan for sharing water storage in Tadpole Lake with Westbank Irrigation District to secure minimum flow for Powers Creek.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Lake, Stream
Location(s): Lake; Tadpole Lake, tributary to North Lambly/Lambly Creeks, Okanagan Lake, Okanagan/Columbia Rivers, NW of Westbank.

Mission Creek

This fifth order stream measures 74.3 km in length and flows from the east to Okanagan Lake. The confluence is located approximately 5 km south of the City of Kelowna. The importance of Mission Creek to the fish populations of this watershed is considered to be very high.

Several enhancement projects have been conducted on Mission Creek. The most noteworthy of such projects is the construction of a spawning channel.

Fish species present in Mission Creek include burbot, kokanee, longnose dace, peamouth chub, rainbow trout, redside shiner, and suckers. Extensive stocking of kokanee fry by the Skaha Hatchery has also occurred in Mission Creek.

Table 38: Mission Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 19km u/s	Gallagher's Falls at 19km u/s	
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	P2		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	DG		
Large Woody Debris	P2		
Percent Pool	DG		

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 19km u/s	Gallagher's Falls at 19km u/s	
< 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	F2		
Stream Flow			
Resembles Natural Hydrograph	P2		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	P2		
Stream Bank Stability	G2		
Floodplain Connectivity	P2		

Construction of flood control dikes has resulted in extensive stream channelization. These measures protect surrounding land from spring freshet and other flood events. This process has resulted in the redistribution of gravel beds, and thus decreased the amount of suitable spawning habitat. At least half of the accessible stream length (which is nearly 19 km) has been channelized, dredged, and straightened. Diking of these lower reaches has, however, resulted in stable streambanks in this area.

Falls located approximately 19 km upstream of the confluence to Okanagan Lake are a migration barrier to all species of fish. A cascade located upstream of the falls represents an additional potential barrier to further upstream migration.

Dams have been located on Mission Creek to provide Kelowna City District with an ample water supply. Decreases in water discharge flows have reduced the amount of available gravel for spawning and egg incubation purposes. If low water flows continued into a warm September, the water temperature could become lethal for kokanee eggs. It appears that fisheries flow objectives cannot be met without provision of additional storage at considerable cost. Annual cleaning of spawning gravel may have a high benefit to cost ratio.

Projects Undertaken

The closing of the kokanee fishery in addition to rebuilding the spawning channel is expected to increase kokanee escapement to Mission Creek. Protection and enhancement of fish habitat, water flows, and water quality should be considered top priorities for this watershed.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Mission Creek Watershed Restoration
Description: Mission Creek watershed is 858 sq. km in area with elevations ranging from 342 m at its confluence with Okanagan Lake to a max of 2,171 m at the summit of Little White Mountain. Sixty percent of the watershed is above 1300 m in elevation. The watershed is located on the Okanagan Highland physiographic division with the dominant bedrock in this area being Monashee Gneiss. Mission Creek is the largest tributary of Okanagan Lake and is part of the Columbia drainage basin. A total of 1,157 km of forest road was identified in the watershed.
Objective: The objective of this project is to rehabilitate and restore the watershed from past disturbances such as road construction by logging companies.
Project Status: Active **Start Date:** 01-APR-97
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Restoration **-** Overview Assessment
Description: This activity includes three sections 1) Integrated Watershed Restoration Plan (IWRP), 2) Access Management Strategy (AMS), and 3) Interior Watershed Assessment (IWAP). The result of the assessment work that has been carried out in the watershed provides recommendations for the subsequent phases involving prescription work and restoration. Watershed-level planning objectives and an access management strategy was produced.
Comment: Report Title: Integrated Watershed Restoration Plan for the Mission Creek Watershed (including Access Management and IWAP) Percentage of Work Completed: Uncertain MoF works done in 1997 and some informal monitoring was done
Activity Term: Start date: 01-MAR-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Mission Creek, tributary to Okanagan Lake. Located just East of Kelowna.

Project Name: Kelowna Education, Streamkeeper, and Habitat Project Coordination
Description: Coordination of school classroom incubation, Streamkeepers, bank stabilization, interpretive fieldtrips. Project involves numerous community organizations.
Project Status: Active **Start Date:** 01-JAN-96
Lead Proponent: City of Kelowna
Activity: Other - General
Description: Project coordination.
Activity Term: Start date: 01-JAN-96 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, Kelowna.
Activity: Enhancement - Fish Culture Activities
Activity Term: Start date: 01-JAN-96 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, Kelowna.
Activity: Restoration **-** Riparian Restoration / Rehabilitation
Activity Term: Start date: 01-JAN-96 End date:
Target Species: Kokanee
Habitat(s): Riparian, Stream
Location(s): Main Stem of Stream; Mission Creek, Kelowna.
Activity: Restoration **-** Riparian Restoration / Rehabilitation
Activity Term: Start date: 01-JAN-96 End date:
Target Species: Kokanee

Habitat(s): Riparian, Stream
Location(s): Main Stem of Stream; Mission Creek, Kelowna.

Project Name: Okanagan Timber Supply Area (TSA) Small Lakes Inventory
Description: 1:20K reconnaissance lake inventory
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Lake Reconnaissance F+FH Inventory
Activity Term: Start date: 01-APR-98 End date:
Habitat(s): Lake; Un-named lake, WB_KEY_WG: 00685OKAN, tributary to un-named creek, tributary to Loch Katrine/Mission Creeks/Okanagan/Columbia Rivers, south of Lumby; Loch Oichie (too small to display in FPR), tributary to Stanley Creek, tributary to Mission Creek/Okanagan/Columbia Rivers, south of Lumby.

Project Name: Mission Creek Kokanee Habitat Enhancement
Description: Planning phase for water management and fish enhancement goals for the lower 8km of Mission Creek.
Project Status: Active **Start Date:** 01-FEB-99 **End Date:** 31-MAR-00
Lead Proponent: Okanagan University College
Activity: Other - General
Description: Planning to increase spawning habitat capacity.
Activity Term: Start date: 01-FEB-99 End date: 31-MAR-00
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Mission Creek tributary to Okanagan Lake/Okanagan/Columbia River near Kelowna.

Project Name: Mission Creek Spawning Channel Improvements
Description: The existing 1000 m long diversion channel improved for spawning kokanee: existing intake structures realigned, gravel placed, and channel regraded.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Improvements to the existing 1000 m long diversion channel for spawning kokanee: existing intake structures realigned, gravel placed, and channel regraded.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.

Project Name: Kelowna/Nelson Spawning Gravel Cleaning Equipment Tests
Description: UBC testing and evaluations of gravel cleaning equipment which remove fine sediments from spawning substrates through hydraulic agitation and suction discharge.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.

Project Status: Active **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Assessment - Other
Description: UBC testing and evaluations of gravel cleaning equipment which remove fine sediments from spawning substrates through hydraulic agitation and suction discharge.
Activity Term: Start date: 01-APR-88 End date:
Location(s): Point; Kelowna region, mid Okanagan.

Project Name: Okanagan Storm Drain Marking Program (89)
Description: Implementation of a Storm Drain Marking program in the Okanagan: coordination of school groups and volunteers, marking of storm drains, and distribution of pamphlets.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other - General
Description: Coordination of school groups and volunteers, marking of storm drains, and distribution of pamphlets.
Activity Term: Start date: 01-APR-89 End date:
Location(s): Point; City of Kelowna.

Project Name: Mission Creek Spawning Channel Evaluation (90)
Description: Evaluation of spawning channel enhancements with estimates of kokanee egg to fry survival rates.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-90
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Assessment - Habitat Assessment
Description: Evaluation of spawning channel enhancements with estimates of kokanee egg to fry survival rates.
Activity Term: Start date: 01-APR-90 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.
Activity: Assessment - Habitat Assessment
Description: Evaluation of spawning channel enhancements with estimates of kokanee egg to fry survival rates.
Activity Term: Start date: 01-APR-90 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.

Project Name: Mission Creek Spawning Channel Evaluation (91)
Description: Enumeration of fry and adult kokanee to assess effectiveness of the spawning channel.

Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-91
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Assessment - Habitat Assessment
Description: Enumeration of fry and adult kokanee to assess effectiveness of the spawning channel.
Activity Term: Start date: 01-APR-91 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.
Activity: Assessment - Habitat Assessment
Description: Enumeration of fry and adult kokanee to assess effectiveness of the spawning channel.
Activity Term: Start date: 01-APR-91 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.

Project Name: Mission Creek Spawning Channel Evaluation (92)
Description: Enumeration of fry and adult kokanee to assess effectiveness of the spawning channel
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-92
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Assessment - Habitat Assessment
Description: Enumeration of fry and adult kokanee to assess effectiveness of the spawning channel
Activity Term: Start date: 01-APR-92 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.
Activity: Assessment - Habitat Assessment
Description: Enumeration of fry and adult kokanee to assess effectiveness of the spawning channel
Activity Term: Start date: 01-APR-92 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.

Project Name: Mission Creek Spawning Channel Evaluation (93)
Description: Final year of fry output studies. Required to firm up egg-fry survival estimator for Okanagan spawning channels.

Project Status: Active **Start Date:** 01-APR-93
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Assessment - Stock Assessment
Description: Final year of fry output studies.
Activity Term: Start date: 01-APR-93 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Mission Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Kelowna.

Project Name: Mission Creek Awareness
Description: Construct a 12-panel information kiosk, and prepare a brochure to promote fisheries awareness.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other - General
Description: Construct a 12-panel information kiosk, and prepare a brochure to promote fisheries awareness.
Activity Term: Start date: 01-APR-89 End date:
Target Species: All species
Location(s): Main Stem + Tributaries; Mission Creek tributary to Okanagan lake/Okanagan/Columbia Rivers.

Naramata Creek

Flowing through the village of Naramata is Naramata Creek, a third order stream measuring 12.7 km in length.

Fish species present in the system include kokanee and rainbow trout.

Table 39: Naramata Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 1.6km u/s	1.6km to 2.4km u/s of confluence	
Water Quality			
Dissolved Oxygen	DG	DG	
Stream Temperature	DG	DG	
Turbidity/Suspended Sediment	DG	DG	
Nutrient Loading	DG	DG	
In Channel Habitat			
Fine Sediment (substrate)	F1	DG	
Large Woody Debris	DG	DG	
Percent Pool	DG	DG	
≤ 2%			
2-5%			
>5%			

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 1.6km u/s	1.6km to 2.4km u/s of confluence	
Habitat Access			
Fish Passage	DG	P1	
Stream Flow			
Resembles Natural Hydrograph	DG	DG	
Impervious Surface	DG	DG	
Stream Corridor			
Riparian Vegetation	DG	DG	
Stream Bank Stability	DG	DG	
Floodplain Connectivity	DG	DG	

Habitat complexity and trout rearing opportunities appear to improve with increasing distance from the confluence with Okanagan Lake. However, it is unlikely that more than 1.6 to 2.4 km of this system is accessible to migrating trout. A culvert and the rapidly increasing stream grade would restrict further fish passage. Most suitable substrate available for kokanee spawning is located within the lower reaches of Naramata Creek.

Approximately 3.4 km upstream of the confluence with Okanagan Lake is a 3.5 m high dam that prevents fish access upstream. Further upstream, a 5 m high falls may possibly be an additional fish barrier.

Projects Undertaken

Naramata citizens installed spawning platforms to increase potential habitat for spawning and egg incubation purposes. Fish and fish habitat inventories have also been conducted on Naramata Creek.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Naramata Creek Watershed Restoration
Description: The project area is located 15 km northeast of the City of Penticton and consists of three watersheds: Naramata Creek, Robinson Creek, and Upper Chute Creek. Naramata watershed has an area of 2931 ha and is used for both domestic and irrigation purposes.
Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Restoration - Detailed Assessments and Prescriptions
Description: Summarizes the results of a surface and ground water hydrology assessments carried out in the Naramata watersheds. Primary concern is the impact of forest development on water quality and quantity due to ongoing infestations of mountain pine beetle and spruce bark beetle. Activity report includes: Introduction, objectives, study area description, previous work description, assessment methods, groundwater hydrology and results.
Comment: Report Title: Surface and Groundwater Hydrology Assessments in the Naramata Watersheds Percentage of Work Completed: None Informal Monitoring in Progress

Activity Term: Start date: 01-NOV-96 End date:
Habitat(s): Stream
Location(s): Watershed; Naramata Creek, tributary to the Okanagan River. Located just North of Penticton. WSC: 310-660700
Activity: Restoration - Overview Assessment
Description: An Integrated Watershed Restoration Plan including a Sediment Source Survey (SSS) and Access Management Plan for the Naramata-Robinson-Chute Creek was conducted. The SSS has identified 3 high, 3 moderate and 13 low priority sites for rehabilitation. Access management maps have recommended 15 km of roads to be permanently deactivated. Activity report includes: photo documentation, SSS, access management maps, watershed characteristics, and objectives.
Comment: Report Title: Integrated Watershed Restoration Plan Percentage of Work Completed: None Informal Monitoring in Progress
Activity Term: Start date: 01-DEC-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Naramata Creek, tributary to the Okanagan River. Located just North of Penticton. WSC: 310-660700
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This activity produced the prescriptions for the priority sites notes in Contract #DPE-WRP-98-GORMANS-1 in the Naramata Creek Watershed. The activity report include: Location Map, Table 1`s and Site location maps, and Keys to Codes in Tables.
Comment: Report Title: Major Works Prescriptions for Priority Sites in the Naramata Creek Watershed Percentage of Work Completed: None Informal Monitoring in Progress
Activity Term: Start date: 01-SEP-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Naramata Creek, tributary to the Okanagan River. Located just North of Penticton. WSC: 310-660700
Activity: Restoration - Overview Assessment
Description: This Geotechnical Evaluation of landslides presents the results of a terrain stability mapping project for the Naramata watershed (approx. 13,400 ha) located in the Okanagan Valley. The report discusses previous work, physiography, drainage, bedrock geology, terrain types and slope stability. Also included are photos, maps, and a section describing the methods used.
Comment: Report Title: Terrain Stability, Naramata Creek Watershed including Geotechnical Evaluation of Landslides along Naramata Creek Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-MAR-96 End date:
Habitat(s): Upslope
Location(s): Watershed; Naramata Creek, tributary to the Okanagan River. Located just North of Penticton. WSC: 310-660700
Activity: Restoration - Detailed Assessments and Prescriptions
Description: A geological engineering assessment of possible landslide was conducted in the Naramata Creek Watershed. The activity report summarizes a review of existing information regarding the landslide site and presents the findings of the field reconnaissance. The nature, condition and potential for reactivation of the landslide is discussed and a hazard and risk rating is presented. The report also includes recommendations regarding forest development in the subbasin that impacts the potential landslide.
Comment: Report Title: Geological Engineering Assessment of Possible Naramata Creek Landslide Percentage of Work Completed: None Informal Monitoring in Progress
Activity Term: Start date: 01-JUL-97 End date:

Habitat(s): Upslope
Location(s): Watershed; Naramata Creek, tributary to the Okanagan River. Located just North of Penticton. WSC: 310-660700
Activity: Restoration - Detailed Assessments and Prescriptions
Description: Naramata Creek and Robinson Creek are tributaries of Okanagan Lake. The activity report includes: Introduction, methods, report format and project deliverables, description of watersheds, conclusions and recommendations. Aerial photos, (SIS) forms, photo documentation and video tape transcripts are available.
Comment: Report Title: Final Report Watershed Restoration Program Naramata and Robinson Creeks Stream Assessment Percentage of Work Completed: None Informal Monitoring in Progress
Activity Term: Start date: 01-DEC-95 End date:
Habitat(s): Stream
Location(s): Watershed; Naramata Creek, tributary to the Okanagan River. Located just North of Penticton. WSC: 310-660700
Activity: Restoration - Overview Assessment
Description: Report type - Channel Assessment: The objectives of this report are to: Videotape and provide audio commentary of the streams, review video and identify sites as being potentially degraded, conduct ground truthing, review existing literature, compile an inventory of sediment sources to each stream, collect anecdotal info on the streams, prioritize degraded streams, and to identify and recommend further assessment procedures.
Comment: Report title: Naramata and Robinson Creeks Stream Assessment Percentage of Work Completed: N/A Informal monitoring in progress.
Activity Term: Start date: 01-DEC-95 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Naramata Creek, tributary to the Okanagan River. Located just North of Penticton.

Project Name: Nicola/Similkameen/Okanagan River Reconnaissance (1:20 000) Fish and Fish Habitat Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to the Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-99 End date:
Location(s): Main Stem + Tributaries; Naramata Creek, tributary to Okanagan Lake/Okanagan/Columbia Rivers, near Naramata.

Naswhito Creek

Naswhito Creek is a third order stream that measures 25.3 km in length. The stream flows to Okanagan Lake from the west. The confluence is located approximately 2.8 km south of that of Equesis Creek.

Kokanee and rainbow trout are known to exist in Naswhito Creek.

Table 40: Naswhito Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 5km u/s		
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	DG		
Large Woody Debris	DG		
Percent Pool	DG		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1		
Stream Flow			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	DG		
Floodplain Connectivity	P1		

Several dams located in the lower reaches of Naswhito Creek restrict fish passage upstream. A crude irrigation diversion dam has been constructed approximately 0.8 km upstream of the confluence with the lake. This dam creates a site of difficult trout passage and limits further upstream migration by kokanee in the fall.

Habitat qualities below this dam remain compatible with trout production. There is evidence that severe spring flows result in bank erosion. Freshet conditions combined with flood control measures have likely reduced stream productivity. Low flows in late summer and during the fall of most years has reduced the original kokanee population in this stream to remnant numbers.

Approximately 5 km upstream of the confluence the stream becomes too steep to accommodate game fish spawning.

Projects Undertaken

Fish and fish habitat projects undertaken in the watershed include:

Project Name: Equesis/Naswhito/Whiteman Creek Fish Habitat and Passage Assessments
Description: Habitat assessment for approx. 8km.
Project Status: Active **Start Date:** 22-NOV-99 **End Date:** 31-MAR-00
Lead Proponent: Okanagan Nation Fisheries Commission
Activity: Assessment - Habitat Assessment
Description: Assessment of the quality of fish habitat and the diversion structures for ease of fish passage, according to Level 1 fish and fish habitat assessment methods.
Activity Term: Start date: 22-NOV-99 End date: 31-MAR-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Naswhito Creek tributary to Okanagan Lake/Okanagan Columbia River near Vernon.

Project Name: Naswhito Creek Watershed Restoration
Description: The Naswhito Creek watershed is a tributary to Okanagan Lake situated approximately 20 km west of Vernon. The watershed area is approximately 80 sq. km.
Objective: The objectives of this project are to restore the watershed to some level of pre harvest condition, to restore natural hydrology to the area, and to enhance and rehabilitate riparian habitat. Specific actions undertaken may be road deactivation, gully and landslide rehabilitation and sediment source detection.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Riverside Forest Products Limited
Activity: Restoration - Upslope Restoration / Rehabilitation
Description: This activity report outlines the a summary of implemented work at a failure on Browns Creek Forest Service Road, a summary report of road deactivation prescriptions in the watershed, and a summary report for road relocation and road upgrade for the Browns Creek Forest Service Road.
Comment: Report Title: Naswhito Creek Road (aka Browns Creek Forestry Service Road) Relocation and Upgrade, Slide and Stream Channel Restoration and Road Deactivation Percentage of Work Completed: Uncertain
Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Upslope
Location(s): Watershed; The Naswhito Creek watershed is a tributary to Okanagan Lake situated approximately 20 km west of Vernon. Naswhito Creek WSC: 310-958000
Activity: Restoration - Overview Assessment
Description: This activity report outlines the overview fish habitat assessment procedure conducted for the Equesis, Naswhito, Whiteman and Shorts watersheds. The objective of this report was to assess the present condition of watersheds by reviewing historical fish studies, forest harvesting, water quality and discharge, maps and airphotos. The watersheds are located on the west side of Okanagan Lake, west of Vernon, BC
Comment: Report Title: Overview Fish Habitat Assessment Procedure: Equesis, Naswhito, Whiteman and Shorts watersheds Percentage of Work Completed: N/A
Activity Term: Start date: 25-APR-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Shorts Watershed is located just south of Naswhito Creek (20 km west of Vernon) and drains into the West side of Okanagan Lake. It is a main tributary of the Okanagan River. Shorts Creek WSC: 310-946900; Whiteman Watershed is located South of

Naswhito Creek (20 km west of Vernon) and drains into the West side of Okanagan Lake. It is a main tributary of the Okanagan River. Whiteman Creek WSC: 310-905500; Naswhito Creek is located 20 km west of Vernon and drains into the West side of Okanagan Lake. It is a main tributary of the Okanagan River. Naswhito Creek WSC: 310-958000
Activity: Restoration - Overview Assessment
Description: This report outlines the results of the interior watershed assessment procedure conducted on the Naswhito Creek Watershed. The objectives of this report were to document watershed characteristics and conditions, and to determine the potential for cumulative hydrologic impacts that may be associated with past forest development in the watersheds. The Naswhito Creek watershed is a tributary to Okanagan Lake situated approximately 20 km west of Vernon. The watershed area is approximately 80 sq. km.
Comment: Report Title: Interior Watershed Assessment for the Naswhito Creek Watershed Percentage of Work Completed: N/A
Activity Term: Start date: 01-DEC-98 End date:
Habitat(s): Upslope
Location(s): Watershed; The Naswhito Creek watershed is a tributary to Okanagan Lake situated approximately 20 km west of Vernon. Naswhito Creek WSC: 310-958000.

Okanagan Mainstem

The Okanagan Valley is an extended finger of the semi-arid sonoran desert ecotype, which has been made much more attractive to fish and humans by a chain of main valley lakes that unfortunately are fed by relatively few tributaries. Many of these streams are ephemeral in nature, connecting to the main system only during spring freshet flows. Of the 46 named tributaries in the Okanagan region, only 20 are known to support either kokanee salmon or rainbow trout spawning runs.

Kokanee are known to exist in Okanagan and Skaha lakes. Anadromous sockeye are known to spawn just above Lake Osoyoos. No bull trout are known to be in the Okanagan watershed on the Canadian side of the border. The tributaries of this watershed are addressed separately (Matthews and Cannings, pers comm).

Table 41: Okanagan Mainstem Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	"channelized" from Penticton to US border		
Water Quality			
Dissolved Oxygen	G2		
Stream Temperature	P2		
Turbidity/Suspended Sediment	F2		
Nutrient Loading	F2		
In Channel Habitat			
Fine Sediment (substrate)	DG		
Large Woody Debris	P2		
Percent Pool	P-F2		
≤ 2%			

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	"channelized" from Penticton to US border		
2-5% >5%			
Habitat Access			
Fish Passage	F2		
Stream Flow			
Resembles Natural Hydrograph	P2		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	P2		
Stream Bank Stability	G2		
Floodplain Connectivity	P2		

Kokanee is currently a key management focus within the Okanagan Basin. Currently the number of kokanee present in Okanagan Lake represent 10 percent of historical numbers supported by this system. The decline in stocks culminated in the 1995 closure of the kokanee sport fishery. This decline also led to the formation of the Okanagan Lake Action Plan, the focus of which was to define limiting factors to kokanee production and to identify and implement remedial measures.

The increase in urbanization and agricultural land use in the Okanagan Valley has lead to the development of lands adjacent to lakes and streams within the watershed. To protect valuable land, diking and channelization of streams has occurred on many stream within the watershed. Most of the meandering length of the Okanagan River between Penticton and the U.S. border has been converted into a straight channel.

Decline in black cottonwood stands adjacent to streams and lakes within the valley has decreased the amount of large woody debris recruitment potential. In addition, recruitment is poor particularly due to the presence of dikes which remain bare (no planting has occurred on the dikes). Any recruitment of large woody debris at this point is primarily due to beaver activity in the area.

Pools are limited to the natural section of the Okanagan River mainstem. Within the channelized section, drop structures, and weirs create some artificial pools that may serve as fish habitat.

Spawning habitat is currently not a limiting factor to salmonid production in the Okanagan system. However, unstable hydraulic profiles may limit the amount of accessible spawning habitat or may strand emerging fry. Regulating hydraulic profiles to benefit sockeye has a negative effect on kokanee. Off channel rearing habitat in Osoyoos Lake in particular is a problem due to temperature ranges and other external influences.

DO is not likely to be a limiting factor to salmonid use in the mainstem. There appears to be good mixing by the presence of riffles that allows for oxygen absorption. In larger, deeper lakes such as Okanagan Lake, oxygen tends to remain plentiful and is therefore thought to not be a limiting factor.

Temperature is considered to be an issue. Ranges can be in excess of 26 degrees Celsius which can be lethal to salmonids. Regulatory control of water levels greatly influences the water temperature as water quantity influences temperature. In addition, the limited amount of riparian vegetation does little to provide shade, which would also enable a stable water temperature regime to develop. Furthermore, temperature and the amount of dissolved oxygen present in a waterbody are related, and combined can result in negative incubation and migration impacts.

Periodic presence of inorganic debris resulting in water turbidity is not considered to be an issue. Vaseux Creek however does add suspended sediments to the system when flash floods occur. This tributary is the main contributor to fine sediments to the Okanagan River mainstem between Osoyoos and Vaseux lakes.

Streams flowing into the mainstem show high nutrient element (nitrogen and phosphorous) loading. However, most of this loading is not immediately available for plant or algal growth. The rate of supply of nutrients that are available to plants and algae for growth appear to be the limiting factor for overall biological production in the Okanagan mainstem lakes. Some management consideration is apparently being given to adding nutrients into the Okanagan system so as to improve production.

No specific data is available for the determination of contaminants within the system, however, inferences from adjacent land use such as agricultural, urbanization, golf courses, and forestry suggest that inputs into the system are quite likely.

Projects Undertaken

Fish and fish habitat projects undertaken in the watershed include:

Project Name: Okanagan Lake - Mysis Beam Trawl Harvesting Feasibility
Description: In-lake population estimate for mysis shrimp, development of more efficient harvesting techniques, harvest product acceptability, and harvest technique cost benefits.
Project Status: Active **Start Date:** 01-SEP-99 **End Date:** 01-MAR-00
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Inventory - Mapping
Description: Graphed and mapped seven stations and 75+ trawls.
Activity Term: Start date: 01-SEP-99 End date: 01-MAR-00
Target Species: Kokanee, Shrimp
Habitat(s): Lake
Location(s): Lake; Okanagan Lake tributary to Okanagan/Columbia Rivers, near Penticton.
Activity: Assessment - Stock Assessment
Description: 15 kg per 1/2 hour trawl of stock assessed.
Activity Term: Start date: 01-SEP-99 End date: 01-MAR-00
Target Species: Shrimp
Habitat(s): Lake; Okanagan Lake, tributary to Okanagan/Columbia Rivers, near Penticton.

Project Name: Nicola/Similkameen/Okanagan River Reconnaissance (1:20 000) Fish and Fish Habitat Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-99 End date:
Location(s): Okanagan River Watershed

Project Name: Okanagan Basin- Fish Species Presence and Distribution
Description: Review of existing materials/reports within the Ministry of the Environment, Lands and Parks regional office compiled into one report.
Project Status: Active **Start Date:** 26-JUL-99 **End Date:** 31-JAN-00
Lead Proponent: Okanagan Nation Fisheries Commission
Activity: Other - General
Description: Compilation of data.
Activity Term: Start date: 26-JUL-99 End date: 31-JAN-00
Location(s): Point; Okanagan Basin entered by point as Okanagan lake tributary to the Columbia River near WestBank/Kelowna.

Project Name: Okanagan Lake Spawning Habitat Construction
Description: Beach gravel moved to below high water mark from above to create kokanee spawning habitat. Identification of spawning sites during the first year.
Objective: Create shore spawning habitat for kokanee as part of Habitat Conservation Trust Fund's (HCTF) overall objective to appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-83
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Shore spawning habitat created for kokanee by moving beach gravel to below the high water mark from above the high water mark.
Activity Term: Start date: 01-APR-83 End date:
Target Species: Kokanee
Habitat(s): Lake
Location(s): Lake; Okanagan Lake, tributary to Okanagan/Columbia Rivers, near Kelowna.
Activity: Inventory - Other
Description: Spawning sites identified in the first year of the new spawning habitat.
Activity Term: Start date: 01-APR-83 End date:
Target Species: Kokanee
Habitat(s): Lake
Location(s): Lake; Okanagan Lake, tributary to Okanagan/Columbia Rivers, near Kelowna.

Project Name: Okanagan River Habitat Enhancement (86)
Description: Creation of spawning habitat for kokanee in the Okanagan River channel by scarifying 160 m and excavating and replacing gravel throughout 400 m of the channel.
Objective: Create spawning habitat for kokanee as part of Habitat Conservation Trust Fund's (HCTF) overall objective to appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-86
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: 160 m of scarification and 400 m of gravel excavation and replacement.
Activity Term: Start date: 01-APR-86 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Okanagan River, tributary to Columbia River, near Penticton.

Another effort to further the Habitat Conservation Trust Fund's (HCTF) objective to conserve and enhance wild fish populations and their habitats was conducted in the form of a video, information pamphlet, and slide show. The purpose of which is to increase public awareness of the importance of Okanagan lake fisheries and to facilitate habitat protection. BC Ministry of Environment Lands and Parks was the lead proponent for the project.

Project Name: Okanagan Storm Drain Marking (88)
Description: Implementation of a Storm Drain Marking program in the Okanagan: Coordination of school groups and volunteers, marking of storm drains, and distribution of pamphlets.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other - General
Description: Implementation of a Storm Drain Marking program in the Okanagan: coordination of school groups and volunteers, marking of storm drains, and distribution of pamphlets.
Activity Term: Start date: 01-APR-88 End date:
Location(s): Point; City of Kelowna, Okanagan region.

Project Name: Okanagan Storm Drain Marking Program (89)
Description: Implementation of a Storm Drain Marking program in the Okanagan: coordination of school groups and volunteers, marking of storm drains, and distribution of pamphlets.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other - General
Description: Coordination of school groups and volunteers, marking of storm drains, and distribution of pamphlets.
Activity Term: Start date: 01-APR-89 End date:
Location(s): Point; City of Kelowna.

Peachland Creek

Peachland Creek flows from the west, and drains directly to Okanagan Lake south of the town of Peachland, BC. It is a third order waterway, and is 31.2 km long. This stream is headwatered by Peachland Lake, a dammed reservoir whose inflow and outflow are largely regulated by Brenda Mines, the primary water licensee.

Fish species known to be present in Peachland Creek include brook trout, kokanee, and rainbow trout. The Skaha Hatchery has also stocked Peachland Creek with kokanee fry. Peachland Creek is an important kokanee spawning channel and provides viewing of spawning grounds for school programs and other educational purposes.

Table 42: Peachland Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 1.2km u/s	Hardy Falls (10m) at 1.2km u/s	
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	P1		
Large Woody Debris	DG		
Percent Pool	F1		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	F1		
Stream Flow			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	DG		
Floodplain Connectivity	DG		

Only the lower reaches of this system are accessible to spawning trout and kokanee. Hardy Falls, located approximately 1.0 km upstream of the confluence with Okanagan Lake, are 10 m high and represent an impassable barrier to all migrating fish. A dam located at the outlet of Peachland Lake is a barrier to resident fish migration.

The lower reaches of the stream appear to be deficient in trout rearing habitat. The area is relatively homogeneous, and would be even more so without the presence of the rock wing deflectors installed by a local rod and gun club. Despite this provision, gravel abundance and quality appears to be inadequate, particularly in terms of trout spawning requirements.

Although a reliable flow regime is reported to be the greatest fish production asset of this stream, it remains susceptible to periods of periodic flow interruptions as witnessed in late August 1977. It would be desirable to have the release of this stored water be part of an overall plan for the cooperative release of stored volumes held by Brenda Mines and the District of Peachland. An agreement between these two agencies to address the collective needs of all water users on both Peachland and Trepanier creeks would assist in ensuring that fish flow requirements are sustained.

Projects Undertaken

Local rod and gun club members have participated in a modest habitat improvement project in the stream below Hardy Falls. This project entailed building alternate rock wing dams to enhance holding areas and to provide sites for gravel deposition. These measures are primarily intended to benefit kokanee spawning.

A Water Survey Canada station located on Peachland Creek collects water quality and quantity data.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Peachland Creek and Trepanier Creek Watershed Restoration
Description: The Peachland and Trepanier Creeks lie within two adjacent watersheds and are located on the west side of Okanagan Lake by Peachland, BC. The Peachland Creek watershed is 14,150 ha in size and drains into Okanagan Lake approximately 3 km SW of Peachland. The Trepanier Creek watershed is 25, 990 ha in size and also drains into Okanagan Lake at the North end of Peachland. There are approximately 543 km of roads in the watersheds. Both creeks flow approximately 25 km in an easterly direction from their headwaters to their confluences. Urbanization and agriculture occur along the lower 3 km of both watersheds. The Brenda Mine is located near the headwaters of both watersheds. Both watersheds are currently under forest licenses to Riverside Forest Products Limited, Gorman Brothers Lumber Ltd. and the Small Business Forest Enterprise Program.
Objective: This watershed will be assessed to determine what work will need to be completed in order to restore the areas that were damaged by past activities, such as logging.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: District of Peachland
Activity: Restoration - Overview Assessment
Description: The purpose of the Interior Watershed Restoration Plan (IWRP) activity is to integrate the results of the Sediment Source Survey, Access Management Strategy, Fish Habitat Assessment Procedure and Interior Watershed Assessment Procedure to recommend an action plan for the prescription phase. The IWRP incorporates the results of the watershed-level and project planning objectives, as well as summarizing the existing conditions in the watershed and identifying significant problems associated with the roads and streams. It also provides a cost estimate and work schedule to complete prescription work. This procedure was completed within these watershed.

Comment: Report Title: Integrated Watershed Restoration Plan for the Peachland Creek & Trepanier Creek Watersheds Vol. 1 of 5 Percentage of Work Completed: Uncertain Informal Monitoring in Progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Peachland Creek, tributary to Okanagan Lake. Located ~ just South of Peachland.
Activity: Restoration - Overview Assessment
Description: This activity outlines the results of the overview Sediment Source Survey work carried out as part of phase two of the Integrated Watershed Restoration Plan on the Peachland/ Trepanier watersheds.
Comment: Report Title: Sediment Source Survey Report for Peachland Creek & Trepanier Creek Watersheds Vol. 2 of 5 Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Peachland Creek, tributary to Okanagan Lake. Located ~ just South of Peachland.
Activity: Restoration - Overview Assessment
Description: Report type - Access Management Plan: The purpose of the report is to identify the current and proposed future uses of all roads on the watershed based on the needs of stakeholders and other users. Deactivation strategies were proposed for roads where use is suspended for up to three years or more. Also identified on the Access Management Strategy maps are sites or areas on roads, hillslopes and gullies that are causing environmental degradation and require stabilization prescriptions. The report includes a detailed results section that contains review of Sediment Source Survey, review of Forest Industry 5 year development plans, identifies status and non status roads, preliminary maps, public viewing and roads eligible for funding. There are many tables, appendices and maps.
Comment: Report title: Access Management Strategies for the Peachland Creek & Trepanier Creek Watersheds Vol. 3 of 5 Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope
Location(s): Main Stem + Tributaries; Peachland Creek, tributary to Okanagan Lake
Activity: Restoration - Overview Assessment
Description: Report type - Fish Habitat Assessment: This report contains an introduction to the study area with description, methodology section, extensive results and discussion section including fish habitat assessment and fish distribution assessment for both watersheds and a final recommendations section detailing each watershed. There are photos and many maps available.
Comment: Report title: Peachland/Trepanier Creek Watershed- Fisheries Habitat Assessment Procedure 1996 Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 29-MAY-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Peachland Creek, tributary to Okanagan Lake. Located ~ just South of Peachland.
Activity: Restoration - Overview Assessment
Description: Report type - Level 1 Coastal or Interior Watershed Assessment Procedure (CWAP or IWAP): This report contains an introduction and description, methods, results, conclusions and recommendations for both of the watersheds based on the assessment. There are many tables and

appendices including Watershed Assessment Procedure Details, IWAP Report Cards and IWAP forms 1 to 9. There are maps that accompany the report in a separate tube.
Comment: Report title: Interior Watershed Assessment for the Peachland & Trepanier Creek Watersheds Vol. 5 of 5 Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-SEP-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Peachland Creek, tributary to Okanagan Lake. Located ~ just South of Peachland.
Activity: Restoration - Overview Assessment
Description: Report type - Terrain Stability: This report contains sections with an introduction, methods, site description, surficial materials and associated landforms, active geomorphological processes and a discussion of terrain hazards. There is a 1:125,000 scale map and several photos that accompany the report.
Comment: Report title : Peachland and Trepanier Creek Stability Mapping Percentage of Work Completed: N/A Works done in 1998 and some informal monitoring in progress
Activity Term: Start date: 22-JAN-99 End date:
Habitat(s): Upslope
Location(s): Main Stem + Tributaries; Peachland Creek, tributary to Okanagan Lake. Located ~ just South of Peachland.

Project Name: Peachland Creek Kokanee Spawning Enhancement (86)
Description: Enhancement of kokanee spawning habitat by constructing 300 sq. m of gravel platforms upstream from previous enhancement activities.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-86
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Construction of 300 sq. m of gravel platforms upstream from previous enhancement activities.
Activity Term: Start date: 01-APR-86 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake and Okanagan/Columbia Rivers, runs through Peachland.

Project Name: Peachland Creek Kokanee Spawning Enhancement (87)
Description: Enhancement of kokanee spawning habitat by constructing more gravel platforms, cleaning sediment basins, and removing excess debris. Also, eggs collected and kokanee spawners enumerated.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-87
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: More gravel platforms constructed, sediment basins cleaned, and excess debris removed.
Activity Term: Start date: 01-APR-87 End date:
Target Species: Kokanee

Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.
Activity: Enhancement - Fish Culture Activities
Description: Kokanee eggs collected.
Activity Term: Start date: 01-APR-87 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.
Activity: Assessment - Stock Assessment
Description: Enumeration of kokanee spawners.
Activity Term: Start date: 01-APR-87 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.

Project Name: Peachland Creek Tours (88)
Description: Educational tours of kokanee spawning ecology prepared and conducted for school groups and the public.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other - General
Description: Educational tours of kokanee spawning ecology prepared and conducted for school groups and the public.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Lake, Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.

Project Name: Peachland Creek Kokanee Spawning Enhancement (88)
Description: Maintenance and evaluation of previous projects: gravel platforms, siltation control measures, incubation boxes. Construction of an enumeration fence and collection of kokanee eggs.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Restoration - Effectiveness Monitoring & Evaluation
Description: Maintenance and evaluation of previous projects: gravel platforms, siltation control measures, and incubation boxes.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Stream

Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.
Activity: Inventory - Escapement
Description: Construction of an enumeration fence.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.
Activity: Enhancement - Fish Culture Activities
Description: Collection of kokanee eggs.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.

Project Name: Peachland Creek Kokanee Spawning Enhancement (89)
Description: Maintenance of gravel platforms, siltation control measures, and incubation boxes. Evaluations of previous projects by assessing kokanee fry.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Maintenance of gravel platforms, siltation control measures, and incubation boxes.
Activity Term: Start date: 01-APR-89 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.
Activity: Assessment - Stock Assessment
Description: Evaluation of previous projects by assessing kokanee fry.
Activity Term: Start date: 01-APR-89 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.
Activity: Assessment - Stock Assessment
Description: Evaluation of previous projects by assessing kokanee fry.
Activity Term: Start date: 01-APR-89 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.

Project Name: Peachland Creek Kokanee Spawning Enhancement (90)
Description: Maintenance of gravel platforms, and incubation boxes, and control of siltation. Previous projects evaluated by assessing kokanee fry.

Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-90
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Maintenance of gravel platforms and incubation boxes, and control of siltation.
Activity Term: Start date: 01-APR-90 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs though town of Peachland.
Activity: Assessment - Stock Assessment
Description: Evaluation of previous projects by assessing kokanee fry
Activity Term: Start date: 01-APR-90 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.
Activity: Assessment - Stock Assessment
Description: Evaluation of previous projects by assessing kokanee fry
Activity Term: Start date: 01-APR-90 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.

Project Name: Peachland Creek Kokanee Spawning Enhancement (91)
Description: Gravel platforms maintained, siltation controlled, and rock weirs repaired. Previous projects evaluated by assessing kokanee fry.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-91
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Gravel platforms maintained, siltation controlled, and rock weirs repaired.
Activity Term: Start date: 01-APR-91 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs though Peachland.
Activity: Assessment - Stock Assessment
Description: Assessment of kokanee fry to evaluate previous projects.
Activity Term: Start date: 01-APR-91 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.

Project Name: Peachland Creek Tours (89)

Description: Preparation and follow through of educational tours of kokanee spawning ecology for school groups and the public.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other - General
Description: Educational tours of kokanee spawning ecology prepared and conducted for school groups and the public.
Activity Term: Start date: 01-APR-89 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Peachland.

Project Name: Peachland Creek Erosion Control
Description: Construct a series of check dams to minimize siltation in the creek and to stabilize the entire gully that is used by kokanee.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Completed **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Restoration - Instream Restoration / Rehabilitation
Description: Construct a series of check dams to minimize siltation in the creek and to stabilize the entire gully, which is used by kokanee.
Activity Term: Start date: 01-APR-89 End date:
Target Species: Kokanee
Location(s): Main Stem of Stream; Peachland Creek tributary to Okanagan Lake/ Okanagan/Columbia Rivers

Project Name: Peachland Creek Erosion Control
Description: Construct a series of check dams to minimize siltation in the creek and to stabilize the entire gully, which is used by kokanee.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Completed **Start Date:** 01-APR-90
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Construct a series of check dams to minimize siltation in the creek and to stabilize the entire gully, which is used by kokanee.
Activity Term: Start date: 01-APR-90 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek tributary to Okanogan/Osoyoos Lakes, Okanogan/Columbia Rivers.
Activity: Enhancement - Habitat Enhancement
Description: Construct a series of check dams to minimize siltation in the creek and to stabilize the entire gully, which is used by kokanee.
Activity Term: Start date: 01-APR-90 End date:

Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek tributary to Okanogan/Osoyoos Lakes, Okanogan/Columbia Rivers.
Activity: Enhancement - Habitat Enhancement
Description: Construct a series of check dams to minimize siltation in the creek and to stabilize the entire gully that is used by kokanee.
Activity Term: Start date: 01-APR-90 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Peachland Creek tributary to Okanogan/Osoyoos Lakes, Okanogan/Columbia Rivers.

Penticton Creek

Penticton Creek flows from the east and drains to Okanagan Lake at the city of Penticton, BC. This third order stream measures 28.8 km in length.

Brook trout, kokanee, longnose dace, and rainbow trout are present in the system. Additional stocking of kokanee fry by the Skaha Hatchery has also occurred.

Table 43: Penticton Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	DG		
Large Woody Debris	DG		
Percent Pool	DG		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1		
Stream Flow			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	G1		
Floodplain Connectivity	P1		

Urban development within this watershed resulted in the construction of a concrete stream channel in 1950 in an effort to stop flooding in the lower reaches of Penticton Creek. The city of Penticton has launched an initiative to improve the esthetic appearance of this stream by naturalizing the lower reaches and modifying and stepping the existing weirs. This process could include a formal agreement with the city of Penticton for maintenance of base fish flows in the downstream reaches of this stream.

A dam located approximately 4.5 km upstream of the confluence to Okanagan Lake is a barrier to upstream migration of all fish. Several other dams are located on Penticton Creek.

Approximately 30 km upstream of the confluence to Okanagan Lake there is a 16 m high and 32 m long cascade that is probably a migration barrier to resident fish populations.

Projects Undertaken

Water quality and quantity are measured at the Water Survey of Canada station.

Fishway ladders were constructed from the confluence with Okanagan Lake to the spawning grounds of Penticton Creek.

Gravel placement has occurred to enhance potential habitat for spawning and egg incubation and a viewing area has been constructed for educational purposes.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Hedley / McNulty / Cahill / Winters Creek Watershed Restoration
Description: Part of Forest Renewal British Columbia's Watershed Restoration Program, the study area contains the Hedley / McNulty Creek Watershed, the Cahill Creek Watershed and Winters Creek Watershed that together have an area of about 600 sq. km. The study area is located on the Thompson Plateau northeast of the town of Hedley, and north of the Similkameen River valley and Highway 3 between Princeton and Keremeos in southern BC
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and road construction.
Project Status: Active **Start Date:** 01-APR-95
Lead Proponent: Weyerhaeuser Canada Limited
Activity: Restoration - Overview Assessment
Description: The purpose of the Access Management Strategies (AMS) is to identify the current and proposed future uses of all roads in the watershed based on the needs of stakeholders and other watershed users. The report includes: Overview, objectives, methodology, results and conclusions. The appendices include: definitions of road deactivation levels, stakeholders and resource users contact list and comments, land tenure and permit status list and maps.
Comment: Report Title: Access Management Strategies (AMS) for Penticton and Ellis Creek Watersheds (Volume 3 of 5) Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope

Location(s): Watershed; Penticton Creek, tributary to the Okanagan River. Located Just North of Penticton.
Activity: Restoration - Overview Assessment
Description: This report includes the results and discussion of fish habitat assessment and distribution, recommendations and photo documentation. The objective of the Fish Habitat Assessment Procedure (FHAP) was to assess, restore, protect and maintain aquatic and fish habitats that have been impacted by forestry practices.
Comment: Report Title: Fisheries Habitat Assessment Procedure for Penticton and Ellis Creek Watersheds (Vol. 4 of 5) Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-MAY-97 End date:
Habitat(s): Stream
Location(s): Watershed; Penticton Creek, tributary to the Okanagan River. Located Just North of Penticton.
Activity: Restoration - Overview Assessment
Description: The purpose of this report is to integrate results from the Sediment Source Survey (SSS), Access Management Strategy (AMS), Fish Habitat Assessment Procedure (FHAP), and Interior Watershed Assessment Procedure (IWAP). The report also includes a description of the types of overview assessments conducted, watershed conditions, prescriptions for IWRP, problems, priority list and photo documentation.
Comment: Report Title: Integrated Watershed Restoration Plan (IWRP) for Penticton and Ellis Creek Watersheds (Vol. 1 of 5) Percentage of Work Completed: Uncertain Informal Monitoring in progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Stream, Upslope
Location(s): Watershed; Penticton Creek, tributary to the Okanagan River. Located Just North of Penticton.
Activity: Restoration - Overview Assessment
Description: This report includes: Introduction, methods, watershed characteristics, results, conclusions and recommendations. Maps are available in separate tubes. Appendices include: Watershed Assessment Procedure Details, IWAP Report Cards, IWAP Forms and round table minutes.
Comment: Report Title: Interior Watershed Assessment for Penticton Creek and Ellis Creek Watersheds (Vol. 5 of 5) Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Penticton Creek, tributary to the Okanagan River. Located Just North of Penticton.
Activity: Restoration - Overview Assessment
Description: Outlines the Sediment Source Survey (SSS) work carried out as part of Phase 2 of the Integrated Watershed Restoration Plan. The report includes: Introduction, objectives, methodology, assessment results, planning and scheduling for the prescription phase, conclusions and recommendations. Photo documentation also provided.
Comment: Report Title: Sediment Source Survey Report for Penticton and Ellis Creek Watersheds (Vol. 2 of 5) Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Penticton Creek, tributary to the Okanagan River. Located Just North of Penticton.
Activity: Restoration - Overview Assessment

Description: The terrain stability mapping was conducted at Terrain Survey Intensity Level C. It incorporated detailed terrain stability information and interpretations to be used by forest planners to identify areas that require on-site assessments of terrain stability prior to the approval of road construction, cutblock boundaries, timber harvesting methods and silvicultural systems.
Comment: Report Title: Terrain Stability and Terrain Stability Mapping for Penticton Creek Watershed Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-NOV-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Penticton Creek, tributary to the Okanagan River. Located Just North of Penticton.
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This report contains the prescriptions for the priority sites noted in Contract #98-WRP-Prescriptions for the Penticton, Shuttleworth, and Vaseux Watersheds. Also included are the prescriptions for Priority site `S1I` and Road #1603.
Comment: Report Title: Upslope Prescriptions for the Priority Sites in the Penticton Creek, Shuttleworth Creek and Vaseux Creek Watersheds. Percentage of Work Completed: Uncertain Works done in 1999 and some informal monitoring in progress
Activity Term: Start date: 01-SEP-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Penticton Creek, tributary to the Okanagan River. Located Just North of Penticton.

Project Name: Penticton Creek Interpretive Signage Project
Description: 4 interpretive signs designed and developed. Signs pertain to issues to do with Okanagan Lake kokanee and habitat issues on Penticton Creek.
Project Status: Active **Start Date:** 22-NOV-99 **End Date:** 15-MAR-00
Lead Proponent: Penticton Flyfishers
Activity: Other - General
Description: Education: design and development of 4 signs to do with issues of Okanagan Lake kokanee and habitat issues on Penticton Creek.
Activity Term: Start date: 22-NOV-99 End date: 15-MAR-00
Target Species: All species, Kokanee
Habitat(s): Lake, Stream
Location(s): Main Stem of Stream; Penticton Creek, tributary to Okanagan Lake, Okanagan/Columbia, near Penticton.

Project Name: Penticton Creek Resting and Leaping Pool
Description: Improvement of fish ladder to provide access to an additional 0.6 km of stream.
Objective: Increase kokanee production.
Project Status: Active
Lead Proponent: Penticton Flyfishers
Activity: Restoration - Restore Fish Passage
Description: Improvement of fish ladder to provide access to an additional 0.6 km of stream.
Activity Term: Start date: 22-NOV-99 End date: 15-MAR-00
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Penticton Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Penticton.

Powers Creek

Powers Creek flows from the west to Okanagan Lake. It is a fourth order stream, and 29.4 km long. It passes through the community of Westbank, BC.

There are known kokanee and rainbow trout populations in Powers Creek.

Table 44: Powers Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to 2.6km u/s	Bedrock chutes at 2.6km u/s	
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	P1		
Large Woody Debris	DG		
Percent Pool	P1		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P2		
Stream Flow			
Resembles Natural Hydrograph	F1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	P1		
Stream Bank Stability	DG		
Floodplain Connectivity	DG		

A chute located 0.8 km upstream of the confluence with Okanagan Lake has been modified in the past by the Fish and Wildlife Branch to more easily pass trout spawners in the spring. Downstream of this chute the creek is bordered by several private properties, including a large ranch. Past channelization measures to protect this private land have contributed to a reduction in pool numbers and a limited amount of suitable spawning gravel.

The section upstream of this chute is confined within a short, steep-sided canyon. Flat “benches” over the next 1.8 km appear to be highly productive for rainbow trout. The lower chute remains, however, a total barrier to stream spawning kokanee in the fall. Falls and a series of bedrock chutes, located approximately 2.6 km upstream of the confluence, represent an obstruction to further upstream migration.

A dam is located approximately 3.3 km upstream of the confluence with Okanagan Lake.

The greatest natural asset of Powers Creek appears to be its generally favorable flow regime. This condition, combined with relatively undisturbed habitat upstream of the first chute appears promising for future enhancement.

Projects Undertaken

Gravel was added and cleaned to enhance kokanee spawning and egg incubation habitat.

A rock chute was blasted in 1989 to remove this particular obstruction and allow for upstream fish migration. A fishway has been installed at this location to further facilitate fish passage.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Powers Creek Screening
Description: Replacement of an existing unscreened diversion with a screened irrigation diversion to prevent migrating Rainbow trout fry from becoming trapped in an irrigation canal.
Objective: Protect Rainbow trout as part of Habitat Conservation Trust Fund's (HCTF) overall objective to appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-86
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement **-** Barrier Modification / Obstruction Removal
Description: Replacement of an existing unscreened diversion with a screened irrigation diversion.
Activity Term: Start date: 01-APR-86 End date:
Target Species: Rainbow Trout
Habitat(s): Stream
Location(s): Main Stem of Stream; Powers Creek, tributary to Okanagan Lake and Okanagan/Columbia Rivers, near Westbank.

Project Name: Powers Creek Fishway Construction
Description: Construction of a fishway to assist kokanee in bypassing a rock obstruction and reaching their spawning habitat.
Objective: Increase the success of kokanee spawners as part of the Habitat Conservation Trust Fund's (HCTF) overall objective to appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-86
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement **-** Barrier Modification / Obstruction Removal
Description: Construction of a fishway to assist kokanee in bypassing a rock obstruction and reaching their spawning habitat.
Activity Term: Start date: 01-APR-86 End date:
Target Species: Kokanee
Habitat(s): Stream

Location(s): Main Stem of Stream; Powers Creek, tributary to Okanagan Lake and Okanagan/Columbia Rivers, near Westbank.

Project Name: Tadpole Lake Water Storage
Description: Collection of information and development of a plan for sharing water storage in Tadpole Lake with Westbank Irrigation District to secure minimum flow for Powers Creek.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Other - General
Description: Collection of information and development of a plan for sharing water storage in Tadpole Lake with Westbank Irrigation District to secure minimum flow for Powers Creek.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Lake, Stream
Location(s): Main Stem of Stream; Powers Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, NW of Westbank.

Robinson Creek

Robinson Creek flows directly to Okanagan Lake from the east. The confluence with the lake is located just over 0.8 km north of the village of Naramata. The stream itself is a second order stream that measures 8.7 km in length.

Kokanee and rainbow trout populations are present in the system. Kokanee apparently only use the lower reaches. Local residents claim large rainbow trout can be observed in the stream during spring runoff.

Table 45: Robinson Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	P1		
Large Woody Debris	DG		
Percent Pool	DG		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1		

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Stream Flow			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	P1		
Stream Bank Stability	DG		
Floodplain Connectivity	P1		

Near the confluence with Okanagan Lake, Robinson Creek is contained within extensive bank armoring. This armoring features a number of internal drop structures.

A culvert located approximately 1.1 km upstream of the confluence with Okanagan Lake is a migration barrier for all species of fish. Upstream of the lowest road crossing the stream is bordered by orchards and more natural habitat qualities are apparent.

Dams located at the outlets of Naramata and Elinor lakes are also present. These two small headwater reservoirs appear to produce reasonably stable flow, resulting in a strong incentive for some level of trout production. Stream flows are considered to be a low to medium constraint to increasing the fisheries potential of Robinson Creek.

Gravel is not abundant in the stream, and where present the gravel beds have a high fraction of fine materials.

Projects Undertaken

Fish and fish habitat projects undertaken in the watershed include:

Project Name: Robinson Creek Riparian Fencing
Description: Fencing construction was completed for 2 km.
Objective: Protection of rainbow trout and riparian areas.
Project Status: Active **Start Date:** 01-APR-99
Lead Proponent: Naramata Citizens Association
Activity: Restoration **-** Other
Description: Habitat restoration for 2 km; fencing construction completed.
Activity Term: Start date: 01-APR-99 End date:
Habitat(s): Riparian
Location(s): Main Stem + Tributaries; Robinson Creek, tributary to Okanagan Lake/Okanagan/Columbia Rivers, near Naramata

Project Name: Naramata Creek Watershed Restoration
Description: The project area is located 15 km northeast of the City of Penticton and consists of three watersheds: Naramata Creek, Robinson Creek, and Upper Chute Creek. Naramata watershed has an area of 2931 ha and is used for both domestic and irrigation purposes.

Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Restoration - Detailed Assessments and Prescriptions
Description: Naramata Creek and Robinson Creek are tributaries of Okanagan Lake. The activity report includes: Introduction, methods, report format and project deliverables, description of watersheds, conclusions and recommendations. Aerial photos, SIS forms, photo documentation and video tape transcripts are available.
Comment: Report Title: Final Report Watershed Restoration Program Naramata and Robinson Creeks Stream Assessment Percentage of Work Completed: None Informal Monitoring in Progress
Activity Term: Start date: 01-DEC-95 End date:
Habitat(s): Stream
Location(s): Watershed; Robinson Creek, tributary to the Okanagan River. Located just north of Penticton. WSC: 310-665200
Activity: Restoration - Overview Assessment
Description: Report type - Channel Assessment: The objectives of this report are to: Videotape and provide audio commentary of the streams, review video and identify sites as being potentially degraded, conduct ground truthing, review existing literature, compile an inventory of sediment sources to each stream, collect anecdotal info on the streams, prioritize degraded streams, and to identify and recommend further assessment procedures.
Comment: Report title: Naramata and Robinson Creeks Stream Assessment Percentage of Work Completed: N/A Informal monitoring in progress.
Activity Term: Start date: 01-DEC-95 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Robinson Creek, tributary to the Okanagan River. Located just north of Penticton. WSC: 310-665200.

Similkameen Mainstem and Watershed

The Similkameen River is a seventh order stream. In total it traverses 198 km from its source to its mouth. It generally flows from the west. The confluence with the Okanogan River is located in Washington State near Oroville. The basin drains approximately 9,600 square km of the Pacific Northwest, 7,600 square km of which are located within Canada. The Similkameen Valley is one of the hottest and driest areas of Canada. Dominant tree species within the basin include spruce, lodgepole pine, Douglas-fir, and balsam. Soils in the area are stony and have a low capacity to retain moisture limiting arable land to valley bottoms.

American placer gold prospectors just traveling through the basin resulted in the first major influx of people into the Similkameen. Cattle ranching in Princeton and mixed agriculture farming by the Hudson’s Bay Company was also introduced into the area during this period.

Since WWII, ranching, agriculture, forestry and mining have increasingly developed. In addition, the building of the Hope-Princeton Highway opened the area to recreation and tourism.

The area south of Hedley became an important tree fruit producing region. The introduction of intensified orcharding practices and other technological advances resulted in higher crop yields. Grape production became prominent in the valley during the 1970's at which time five commercial vineyards were in operation. Significant limitations to agricultural production in the basin include adverse topography, low rainfall, and stony soil that has low moisture-holding capacity. Arable land is typically located in the valley bottom.

Forestry has been a major economic element in the basin. The largest employer in the region as of 1984 was Weyerhaeuser Canada Ltd. which operates a sawmill in Princeton. Several smaller mills operate in the basin as well. Dominant species in the Similkameen are spruce, Lodgepole pine, Douglas fir and balsam.

Mining opportunities significantly increased over the years as the basin is part of a highly mineralized area which contains several commercial deposits of copper, gold, silver, lead and zinc as well as reserves of low-sulphur thermal coal in the Tulameen area. Several mining companies operate in the basin.

Tourism in the valley was facilitated by the opening of the Hope-Princeton Highway in 1949. The basin offers a variety of activities for both summer and winter tourists. There are ten provincial parks in the basin.

Falls located at the mouth of the Similkameen River have been replaced by a dam. The falls were the historical natural barrier to the upstream migration of anadromous species. There is no passage for anadromous fish beyond the dam. Introducing these fish to the Similkameen may result in disease and habitat competition with resident non-anadromous fish.

Fish species known to be present in the Similkameen River include black bullhead, bridgelip sucker, Dolly varden, largescale sucker, longnose dace, mottled sculpin, mountain whitefish, northern mountain sucker, northern pikeminnow, rainbow trout, redside shiner, sculpins, slimy sculpin, suckers, torrent sculpin, Umatilla dace, and whitefish. Fish stocking of rainbow trout has also occurred in the Similkameen River by the Fraser Valley Hatchery.

Table 46: Similkameen Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	DG		
Large Woody Debris	DG		

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Percent Pool ≤ 2% 2-5% >5%	DG		
Habitat Access			
Fish Passage	DG		
Stream Flow			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	DG		
Floodplain Connectivity	P1		

The Enloe Dam located near the mouth of the Similkameen River is the barrier to upstream migration to anadromous fish. Historically anadromous fish have not migrated past this point due to the presence of impassable falls. Concessions made to enable anadromous fish into this system may increase disease and competition for habitat with resident fish populations.

As of 1984 there were over 1,000 water licenses within the Canadian portion of the basin in operation. The majority of these licenses were used for irrigation purposes, typically in the lower part of the river between Princeton and the border. Estimated diversions during irrigation season were equivalent to a continuous flow of 6.13 cubic m per second at that time. By the end of the summer streams are reduced to base flows and irrigation exacerbates the issue. There is very little lake/reservoir storage within the basin to supplement the late summer low flows.

The other water supply problem is periodic flooding. In the spring and early summer the river experiences its freshet. These freshets commonly results in flooding in the lower valley. Extensive diking has been constructed to protect much of these lands.

Projects Undertaken

Fish and fish habitat projects undertaken in the watershed include:

Project Name: Tulameen Main Line Watershed Restoration
Description: This watershed is 1,780 sq. km in size and is located in southwestern BC, 299 km east of Vancouver. The western portion of the watershed is located in the Cascade Mountains, while the eastern portion is situated within the Thompson Plateau. Elevation in the watershed range between 600 and 2300 m.
Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.

Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Tolko Industries Limited
Activity: Restoration - Overview Assessment
Description: Report type - Channel Assessment: This report contains an introduction and background information, objectives, methods of assessment results and summary. The appendices include filed notes, photo plates, photo documentation forms 1 and 2, water survey of Canada stream flow data, water licenses and watershed maps. (Please note that this is a draft copy and none of the appendices are present).
Comment: Report title: Reconnaissance Channel Assessments in selected tributaries of the Tulameen River Percentage of Work Completed: N/A
Activity Term: Start date: 01-FEB-99 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Tributaries of the Tulameen River, near Princeton.

Project Name: Nicola/Similkameen/Okanagan River Reconnaissance (1:20 000) Fish and Fish Habitat Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-99 End date:
Type: Main Stem + Tributaries; South Keremeos Creek (tributary to Keremeos Creek), Snehumption Creek, Shoudy Creek, Robert Creek, Red Bridge Creek (tributary to Ashnola River), Duruisseau Creek (tributary to Ashnola River), Easygoing Creek (tributary to Ashnola River), tributaries to Similkameen/Okanagan/Columbia Rivers.

Project Name: Merritt Timber Supply Area (TSA) Enhanced Forestry
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Weyerhaeuser Canada Limited
Activity: Inventory - Other
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory; Planning only.
Activity Term: Start date: 01-APR-96 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Dillard Creek, tributary to Summers/Allison Creeks, Summers Creek tributary to Allison Creek, Spukunee Creek tributary to Hayes Creek, Siwash Creek tributary to Hayes Creek, Rampart Creek tributary to Summers Creek – tributaries to Similkameen/Okanagan/Columbia River.

Project Name: Tolko Multi Activity Land-Based 1996
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Tolko Industries Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-96 End date:
Habitat(s): Stream
Location(s): Main Stem and tributaries of Tulameen River, Holmes Creek, tributary to Granite Creek, Fraser Gulch, Collins Creek, Otter Creek, Spearing Creek tributary to Otter Creek, Blakeburn Creek tributary to Granite Creek, Newton Creek tributary to Granite Creek, Manion Creek, tributaries to Tulameen/Similkameen/Okanagan/Columbia River.

Project Name: Tulameen River Watershed Restoration
Description: The Tulameen Watershed is located approximately 200 km east of Vancouver, BC in the Merritt Forest District, between Hope and Princeton, north of Manning Park and south of Merritt. The watershed is about 1780 sq. km in size. The western portion of the Tulameen watershed is located within the Cascade Mountains, while the eastern portion is situated within the Tulameen plateau.
Objective: The objectives of this project were to restore the watershed to some level of pre harvest activity. This may include reestablishing natural hydrology and drainage patterns, revegetation plans and rehabilitating gullies and landslides for reclamation and visual quality purposes. Activities, which may be undertaken in order to accomplish such restoration work, include road deactivation, road rehabilitation or bioengineering.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Restoration - Overview Assessment
Description: Report type - Channel Assessment: This report contains an introduction and objectives, physical setting information, land use impacts and changes in channel morphology, priorities for field inspection, recommendations for channel restoration, future work and certification. There are several figures and tables throughout the report detailing various information discussed within the report. There are also two other volumes that contain only maps and photo plates of the watershed. Three oversized maps accompany this report.
Comment: Report title: Tulameen River Watershed Overview Channel Assessment Percentage of Work Completed: N/A
Activity Term: Start date: 01-APR-99 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Tulameen River, Tributary to the Similkameen River. Located near Princeton.
Activity: Restoration - Overview Assessment
Description: This report outlines the overview channel assessment for the Tulameen watershed. The objectives of this report were to determine how historic land use practices have affected stream channel processes in the watershed. The Tulameen Watershed is located approximately 200 km east of Vancouver, BC The watershed is about 1780 sq. km in size. The western portion of the

Tulameen watershed is located within the Cascade Mountains, while the eastern portion is situated within the Tulameen plateau.
Comment: Report Title: Tulameen River Watershed Overview Channel Assessment (Volume 1 Text). Percentage works completed is: N/A
Activity Term: Start date: 01-APR-97 End date:
Habitat(s): Stream
Location(s): Watershed; Tulameen River, tributary of the Similkameen River, is located approximately 20km west of Princeton.
Activity: Restoration - Overview Assessment
Description: This report outlines the overview channel assessment for the Tulameen watershed. The objectives of this report were to determine how historic land use practices have affected stream channel processes in the watershed. The Tulameen Watershed is located approximately 200 km east of Vancouver, BC The watershed is about 1780 sq. km in size. The western portion of the Tulameen watershed is located within the Cascade Mountains, while the eastern portion is situated within the Tulameen plateau.
Comment: Report Title: Tulameen River Watershed Overview Channel Assessment (Volume 1 Text). Percentage works completed is: N/A
Activity Term: Start date: 01-APR-97 End date:
Habitat(s): Stream
Location(s): Watershed; Tulameen River, tributary of the Similkameen River, is located approximately 20 km west of Princeton.
Activity: Restoration - Overview Assessment
Description: This report outlines the overview channel assessment for the Tulameen watershed. The objectives of this report were to determine how historic land use practices have affected stream channel processes in the watershed. The Tulameen Watershed is located approximately 200 km east of Vancouver, BC The watershed is about 1780 sq. km in size. The western portion of the Tulameen watershed is located within the Cascade Mountains, while the eastern portion is situated within the Tulameen plateau.
Comment: Report Title: Tulameen River Watershed Overview Channel Assessment (Volume 3 Addendums 10-12 Historical Air Photo Analyses Otter Creek and Lower Tulameen Watershed). Percentage works completed is: N/A
Activity Term: Start date: 01-APR-97 End date:
Habitat(s): Stream
Location(s): Watershed; Tulameen River, tributary of the Similkameen River, is located approximately 20 km west of Princeton.
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This report outlines the stream assessment conducted for the Tulameen River. The objective of this report was to compile existing historical information to identify factors that limit fish production and water quality in the watershed, and to determine trends in habitat quality in the watershed. The Tulameen River Watershed is located in the Merritt Forest district, between Hope and Princeton, north of Manning Park and south of Merritt.
Comment: Report Title: 1996 Tulameen River Watershed Stream Assessment: Volume 1 - Final Report. Percentage works completed is: uncertain
Activity Term: Start date: 01-JUL-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Tulameen River, tributary to the Similkameen River, is located approximately 20 km west of Princeton.
Activity: Restoration - Effectiveness Monitoring & Evaluation

Description: This report outlines the stream restoration works, surveys, assessments and prescriptions which have taken place in the past year (1997). The objective of this work is to restore the streams to pre development conditions. The Tulameen River Watershed is located in the Merritt Forest district, between Hope and Princeton, north of Manning Park and south of Merritt.
Comment: Report Title: 1997 Tulameen River Watershed Stream Restoration Final Report. Percentage works completed is: N/A
Activity Term: Start date: 02-MAR-98 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Tulameen River, tributary to the Similkameen River, is located approximately 20 km east of Princeton.
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This report outlines the fish habitat rehabilitation prescriptions for the Granite Creek sub basin of the Tulameen River watershed. The objectives of these prescriptions are to stabilize stream banks and channels, create enhanced fish habitat in streambeds and reduce sediment delivery into the water system. The Tulameen River Watershed is located in the Merritt Forest district, between Hope and Princeton, north of Manning Park and south of Merritt.
Comment: Report Title: 1998 Granite Creek Rehabilitation Prescriptions. Percentage works completed is: uncertain
Activity Term: Start date: 01-SEP-98 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Granite Creek, tributary to Tulameen River which flows into the Similkameen River, is located approximately 20 km west of Princeton.

Project Name: Ashnola River Watershed Restoration
Description: The Ashnola River watershed lies on the Thompson Plateau and is bordered to the south by the Canada USA border. It flows northwest into the Similkameen River, and drains an area of 879.3 ha. The objectives of this project were to restore the watershed to some level of pre harvest activity. This may include reestablishing natural hydrology and drainage patterns, revegetation plans and rehabilitating gullies and landslides for reclamation and visual quality purposes. Activities, which may be undertaken in order to accomplish such restoration work, include road deactivation, road rehabilitation or bioengineering.
Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Lower Similkameen Indian Band
Activity: Restoration - Overview Assessment
Description: Report type - Level 1 Coastal or Interior Watershed Assessment Procedure (CWAP or IWAP): This report outlines the interior watershed assessment procedure for the Ashnola River Watershed. The objectives of this report were to determine the potential for any cumulative hydrologic impacts resulting from past forest development. The Ashnola River watershed lies on the Thompson Plateau and is bordered to the south by the Canada USA border. It flows northwest into the Similkameen River, and drains an area of 879.3 ha.
Comment: Report title: Interior Watershed Assessment Procedure: Ashnola River Watershed Percentage of Work Completed: N/A Works done in 1999 and some informal monitoring in progress
Activity Term: Start date: 01-APR-98 End date:
Habitat(s): Riparian, Stream, Upslope

Location(s): Main Stem + Tributaries; Ashnola River, tributary to Similkameen River, near Princeton
Activity: Restoration - Overview Assessment
Description: Report type - Sediment Source Survey: This report contains an introduction, methods, results and recommendations. The appendices include data cards and photos, fish sampling methods and results, Forms 1-3 and 8: Channel Assessment Procedure (CAP) Overview Documentation and Field Forms. There is another volume that includes only photos and maps. This report is intended to identify the sites of impact and recommend means of restoring habitats and ecosystem functions within the Ashnola River Watershed. To assist in the identification of potential impacts, the following assessments were conducted. An overview Channel Assessment Procedure was conducted on the channel morphology of selected streams within the Ashnola River watershed and a sediment source survey evaluated potential sediment sources from roads, cutblocks and natural sources including landslides.
Comment: Report title: Ashnola River Watershed Channel Assessment Procedure & Sediment Source Survey Percentage of Work Completed: N/A Works done in 1999 and some informal monitoring in progress
Activity Term: Start date: 01-JAN-98 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Ashnola River, tributary to the Similkameen River, near Keremeos.

Project Name: Arrastra Creek Watershed Restoration
Description: The watershed is located 40 km SW of Princeton, BC and encompasses 150 sq. km which drains the east side of the Cascade Mountains into Granite Creek, Tulameen and eventually Similkameen Rivers. The watershed had been modified through timber harvesting and livestock free ranging. This area is also heavily used for recreation.
Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.
Project Status: Active **Start Date:** 01-APR-94
Lead Proponent: First Nations of Okanagan-Similkameen Environmental Protection Society
Activity: Restoration - Instream Restoration / Rehabilitation
Description: Report type - In Stream & Off Channel Rehabilitation: This report contains executive summary, background, watershed characteristics, project design, implementation summary and recommendation for future work. There are some tables and figures as well as photos and diagrams.
Comment: Report Title: Arrastra Creek Watershed Restoration Project Percentage of Work Completed: Uncertain
Activity Term: Start date: 01-NOV-98 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Arrastra Creek, tributary to the Similkameen River watershed, is located about 40 km SW of Princeton, BC
Activity: Restoration - Instream Restoration / Rehabilitation
Description: Report type - In Stream & Off Channel Rehabilitation: This report contains executive summary, background, watershed characteristics, project design, implementation summary and recommendation for future work. There are some tables and figures as well as photos and diagrams.
Comment: Report Title: Arrastra Creek Watershed Restoration Project Percentage of Work Completed: Uncertain

Activity Term: Start date: 01-NOV-98 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Arrastra Creek, tributary to the Similkameen River watershed, is located about 40 km SW of Princeton, BC

Project Name: Granite Creek Watershed Restoration
Description: The watershed is located in the Penticton Forest District west of Princeton, BC and drains into the Tulameen River.
Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: Ardew Wood Products Ltd.
Activity: Restoration - Instream Restoration / Rehabilitation
Description: Report type - Work Summary: This report contains an introduction, methods, detailed work plan, results, recommendations and budget summary. There are a few tables and figures detailing costs, location site and collected data. The appendices include photographs, agency approval, daily work sheets and field data sheets.
Comment: Report title; 1998 Granite Creek Restoration Works Percentage of Work Completed: Uncertain Informal Monitoring in Progress
Activity Term: Start date: 01-FEB-99 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Granite Creek, Similkameen River watershed, near Princeton.

Project Name: Wolfe Creek Watershed Restoration
Description: Part of Forest Renewal British Columbia's Watershed Restoration Program, Wolfe Creek originates in the Cascade Mountains and Wilbert Hills in southern BC It flows in a general northeast direction, discharging into the Similkameen River east of Princeton at the Wolf Indian Reserve No. 3. The watershed is 238 sq. km in area and has one major tributary named Willis Creek.
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and road construction.
Project Status: Active **Start Date:** 01-APR-95
Lead Proponent: First Nations of Okanagan-Similkameen Environmental Protection Society
Activity: Restoration - Overview Assessment
Description: The general objective of the Integrated Watershed Restoration Plan is to develop a strategy to adequately protect natural resources (fisheries, water, timber) while maintaining access to, and use of these resources by stakeholders in the watershed. Volume 1 of the report provides descriptions of this project's Sediment Source Survey, Fish Habitat Assessment Procedure, Channel Conditions and Prescriptions Assessment, Access Management Plan, as well as preliminary restoration recommendations.
Comment: Report Title: Wolfe and Willis Creeks: Integrated Watershed Restoration Plan (Vol.1 of 2). Percentage works completed is: uncertain
Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Willis Creek, tributary to Wolfe Creek which flows into the Similkameen River, is located less than 20km east of Princeton; Wolfe Creek, tributary to the Similkameen

River, is located less than 20km east of Princeton.
Activity: Restoration - Overview Assessment
Description: The general objective of the Integrated Watershed Restoration Plan is to develop a strategy to adequately protect natural resources (fisheries, water, timber) while maintaining access to, and use of these resources by stakeholders in the watershed. Volume 2 of the report contains the attachments, specifically the Sediment Source Survey map, the FHAP / CCPA map, and the Access Management Map.
Comment: Report Title: Wolfe and Willis Creeks: Integrated Watershed Restoration Plan (Vol.2 of 2). Percentage works completed is: uncertain
Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Willis Creek, tributary to Wolfe Creek which flows into Similkameen, is located less than 20km east of Princeton; Wolfe Creek, tributary to the Similkameen River, is located less than 20km east of Princeton.
Activity: Restoration - Overview Assessment
Description: The primary objective of this project is to identify potential watershed impacts in the Wolfe Creek drainage due to forest harvest practice. Further objectives include but are not limited to: - updating existing forest road and cutblock information; - evaluating forestry impacts relative to other land use impacts within the watershed; - investigating water quality conditions at two locations along Wolfe Creek; - preparing a report which includes 1:20,000 digital mapping and; - providing recommendations for further assessment, if required.
Comment: Report Title: Wolfe Creek: Level I Interior Watershed Assessment. Percentage works completed is: N/A
Activity Term: Start date: 06-SEP-96 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Wolfe Creek, tributary of the Similkameen River, is located less than 20km east of Princeton.

Project Name: Hedley / McNulty / Cahill / Winters Creek Watershed Restoration
Description: Part of Forest Renewal British Columbia's Watershed Restoration Program, the study area contains the Hedley / McNulty Creek Watershed, the Cahill Creek Watershed and Winters Creek Watershed that together have an area of about 600 sq. km. The study area is located on the Thompson Plateau northeast of the town of Hedley, and north of the Similkameen River valley and Highway 3 between Princeton and Keremeos in southern BC
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and road construction.
Project Status: Active **Start Date:** 01-APR-95
Activity: Restoration - Overview Assessment
Description: This Integrated Watershed Restoration Plan (IWRP) produced a report, which summarizes the overview assessments with the tabulated results within the Appendices. An Interior Watershed Assessment Procedure for the Hedley Watershed was prepared in 1996 by Dobson Engineering. The Watershed-level and Proposed Component Project Objectives as well as the details of the Watershed Restoration Plan (WRP) Access Management Plan are presented within this report. Appendix VI for this report is under separate cover.
Comment: Report Title: Hedley / McNulty, Cahill and Winters Creeks Watersheds: Integrated Watershed Restoration Plan. Percentage of Work Completed: Uncertain Informal Monitoring in Progress
Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Riparian, Stream, Upslope

Location(s): Watershed; Winters Creek, McNulty Creek, tributary of Hedley Creek, Hedley Creek, Cahill Creek, tributaries to the Similkameen River, is located just south of Princeton.
Activity: Restoration - Overview Assessment
Description: This activity presented an overview of the stability conditions of the roads, hillslopes and gullies in the study area. The goal of the Sediment Source Survey is to identify erosion problems with existing roads, hillslopes and gullies, and to determine sites that require rehabilitation. Each feature is assessed for the level of risk it presents to environmental, social and economic values, and general prescriptions for rehabilitation are given if required.
Comment: Report Title: Hedley/ McNulty, Cahill and Winters Watersheds: Sediment Source Surveys. Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 16-FEB-98 End date:
Habitat(s): Upslope
Location(s): Watershed; McNulty Creek tributary to Hedley Creek, Cahill Creek, Winters Creek, Hedley Creek, tributaries to the Similkameen River, is located just south of Princeton.
Activity: Restoration - Overview Assessment
Description: The objective of the Level I Interior Watershed Restoration Plan (IWAP) is to assess the potential for cumulative hydrologic impacts in the Winters and Cahill Creeks Watersheds associated with previous forest development and road construction. There are four primary impact categories that are assessed which include: - peak flows; - surface erosion; - riparian buffers and; - mass wasting. The results of this assessment should be considered in the review of restoration work that might be recommended for the watershed, as well as in the evaluation of future harvesting proposals in the watershed.
Comment: Report Title: Winters and Cahill Creeks Watersheds: Interior Watershed Assessment Procedure. Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-NOV-97 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Winters Creek, Cahill Creek, tributaries to the Similkameen River, is located just south of Princeton.
Activity: Restoration - Overview Assessment
Description: The objective of the Level I Interior Watershed Assessment Procedure (IWAP) is to assess the potential for cumulative hydrologic impacts in the Hedley / McNulty Creek Watershed associated with previous forest development and road construction. There are four primary impact categories that are assessed which include: - peak flows; - surface erosion; - riparian buffers and; - mass wasting. The results of this assessment should be considered in the review of restoration work that might be recommended for the watershed, as well as in the evaluation of future harvesting proposals in the watershed.
Comment: Report Title: Hedley Creek Interior Watershed Assessment Procedure. Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-MAR-96 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Hedley Creek, tributary to the Similkameen River, is located just south of Princeton.

Project Name: Willis Creek Watershed Restoration
Description: The Willis Creek watershed is located approximately 20 km south of Princeton, BC The study area consists of a 4 km section of the Willis Creek valley and valley sides.
Objective: The objectives of this project were to restore the watershed to some level of pre harvest activity. This may include reestablishing natural hydrology and drainage patterns, revegetation plans and rehabilitating gullies and landslides for reclamation and visual quality

purposes. Activities, which may be undertaken in order to accomplish such restoration work, include road deactivation, road rehabilitation or bioengineering.
Project Status: Active **Start Date:** 01-APR-96
Activity: Restoration - Overview Assessment
Description: This report provides a summary of the results of two site visits conducted to view new slides in the spring of 1997, detailed prescriptions and a cost estimate for remediation of the new slide areas, and prioritization of works to be completed. Willis and Commander forest service roads are near the community of Princeton.
Comment: Report Title: Prescriptions for Willis/Commander Road. Percentage works completed is: 100 percent
Activity Term: Start date: 19-SEP-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Willis Creek, tributary of Wolfe Creek which flows into the Similkameen River, is located approximately 20 km south of Princeton.
Activity: Restoration - Overview Assessment
Description: This report outlines a field review of the remedial treatment measures carried out along a segment of the Old Commander road, just south of its junction with the Willis Creek Mainline. The purpose of the review was to assess the efficacy of site rehabilitation measures carried out to date. The Willis/ Commander area is located south of Princeton, BC
Comment: Report Title: 1998 Review of the Slide Reclamation Area: Old Commander Road, Willis Creek Basin. Percentage works completed is: 100 percent
Activity Term: Start date: 25-SEP-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Willis Creek, tributary of Wolfe Creek which flows into the Similkameen River, is located approximately 20 km south of Princeton.
Activity: Restoration - Overview Assessment
Description: This report outlines the results of a study of an approximately 100 ha area of the Willis Creek Basin. The purpose of the study was to develop detailed prescriptions for restoration and rehabilitation of road, landslide and gully elements potentially having a detrimental impact on water quality and habitat in Willis Creek. The Willis Creek watershed is located approximately 20 km south of Princeton, BC The study area consists of a 4 km section of the Willis Creek valley and valley sides.
Comment: Report Title: Willis Creek and Old Commander Road Rehabilitation Project. Percentage works completed is: 100 percent
Activity Term: Start date: 03-OCT-96 End date:
Habitat(s): Upslope
Location(s): Watershed; Willis Creek, tributary of Wolfe Creek which flows into the Similkameen River, is located approximately 20 km south of Princeton.

Project Name: Northwest Tulameen River Watershed Restoration
Description: Part of Forest Renewal British Columbia's Watershed Restoration Program, the Northwest Tulameen Watershed is located south of Merritt, BC and includes an area of approximately 42,500 ha. The study area is generally bounded by the Tulameen River and the Illal Creek to the south, Otter Creek to the east, Spearing Creek to the north, and the Coldwater River basin to the west.
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and road construction.
Project Status: Active **Start Date:** 01-APR-95
Lead Proponent: Tolko Industries Limited

Activity: Restoration - Overview Assessment
Description: The Integrated Watershed Restoration Plan (IWRP) includes descriptions of the project's Sediment Source Survey, Stream Channel and Fish Habitat Assessment, and Access Management Plan, as well as a determination of Watershed Level Objectives.
Comment: Report Title: Northwest Tulameen River: Integrated Watershed Restoration Plan. Percentage works completed is: uncertain
Activity Term: Start date: 31-MAR-98 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; The Tulameen River, tributary to the Similkameen River, is located approximately 20 km west of Princeton.

Project Name: Old Arrastra Creek Watershed Restoration
Description: The Arrastra Creek Forest Service Road is located approximately 25 km west of Princeton, BC The area assessed consisted of approximately 1.3 km of the old Arrastra Creek Forestry Service Road.
Objective: The objectives of this project were to restore the watershed to some level of pre harvest activity. This may include reestablishing natural hydrology and drainage patterns, revegetation plans and rehabilitating gullies and landslides for reclamation and visual quality purposes. Activities, which may be undertaken in order to accomplish such restoration work, include road deactivation, road rehabilitation or bioengineering.
Project Status: Active **Start Date:** 01-APR-97
Lead Proponent: BC Ministry of Forests
Activity: Restoration - Upslope Restoration / Rehabilitation
Description: This report outlines road deactivation prescriptions conducted for the Old Arrastra Creek FSR area. Road deactivation prescriptions were developed for this area because of the need to reduce the potential delivery of sediment into Granite Creek and to stabilize existing sediment sources in order to protect fish and fish habitat in Granite Creek. The Arrastra Creek Forest Service Road is located approximately 25 km west of Princeton, BC The area assessed consisted of approximately 1.3 km of the old Arrastra Creek Forestry Service Road.
Comment: Report Title: Old Arrastra Creek Forestry Service Road. Percentage works completed is: 100 percent
Activity Term: Start date: 01-MAR-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Arrastra Creek, tributary to Granite Creek which flows into the Tulameen River, is located approximately 25 km west of Princeton.
Activity: Restoration - Upslope Restoration / Rehabilitation
Description: This report summarizes the results of the equipment supervision carried out on Oct 10-12 for the slope failure on the Arrastra Creek forest service road near Princeton. The Arrastra Creek Forest Service Road is located approximately 25 km west of Princeton, BC The area assessed consisted of approximately 1.3 km of the old Arrastra Creek Forestry Service Road.
Comment: Report Title: Equipment Supervision for Slump on Arrastra Creek Forest Service Road at Blakeburn Bridge. Percentage works completed is: 100 percent
Activity Term: Start date: 30-OCT-96 End date:
Habitat(s): Upslope
Location(s): Watershed; Arrastra Creek, tributary to Granite Creek which flows into the Tulameen River, is located approximately 25 km west of Princeton.
Activity: Restoration - Upslope Restoration / Rehabilitation
Description: This report summarizes the results of field reconnaissance carried out on September 30, 1996, of the slope failure on the Arrastra Creek Forest service road near Princeton.

The failure is located on Arrastra Creek FSR at the east approach to the east approach of the bridge on Blakeburn Creek. The Arrastra Creek Forest Service Road is located approximately 25 km west of Princeton, BC The area assessed consisted of approximately 1.3 km of the old Arrastra Creek Forestry Service Road.
Comment: Report Title: Remedial Works for Slump on Arrastra Creek Forest Service Road at Blakeburn Bridge. Percentage works completed is: 100 percent
Activity Term: Start date: 09-OCT-96 End date:
Habitat(s): Upslope
Location(s): Watershed; Arrastra Creek, tributary to Granite Creek which flows into the Tulameen River, is located approximately 25 km west of Princeton.

Project Name: Tolko Multi-Year Plan 1998
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: Tolko Industries Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-98 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Britton Creek, Lawless Creek, Coates Creek tributary to Holding Creek, Blackeye Creek, Podunk Creek (including Chisholm and Cunningham Creek tribs), Packer Creek, Squakin Creek, Gellatly Creek, Otter Creek (including Manning, Myren, and Gulliford Creeks and other un-named tribs), tributary to Tulameen River, Allison Creek, tributary to Similkameen/Okanagan/Columbia Rivers, near Tulameen.

Project Name: Whipsaw, Smith and Willis Creek Watersheds 1:20K Reconnaissance Fish and Fish Habitat Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-99
Lead Proponent: Weyerhaeuser Canada Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-99 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Willis Creek, tributary to Wolfe Creek, Whipsaw Creek, tributary to Similkameen/Okanagan/Columbia Rivers, near Tulameen; Smith Creek, tributary to Tulameen river, tributary to Similkameen/Okanagan/Columbia Rivers, near Coalmont.

Project Name: Okanagan/Boundary/Similkameen Rivers-Barriers to Fish Passage (Phase 1)
Description: Identification of 186 potential obstructions to fish passage.

Project Status: Active **Start Date:** 01-OCT-99 **End Date:** 03-MAR-00
Lead Proponent: Okanagan Region Wildlife Heritage Fund Society
Activity: Assessment - Habitat Assessment
Description: Identification of 186 non-natural potential barriers to fish passage.
Activity Term: Start date: 01-OCT-99 End date: 03-MAR-00
Target Species: All species
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Similkameen River, tributary to Okanagan/Columbia Rivers, near Princeton.

Project Name: Okanagan Region Inventory of Non-natural Barriers to Fish Passage
Description: 186 potential fish passage obstructions identified to date.
Project Status: Active **Start Date:** 01-OCT-99 **End Date:** 03-MAR-00
Lead Proponent: Okanagan Region Wildlife Heritage Fund Society
Activity: Other - General
Description: 186 potential fish passage obstructions identified to date.
Activity Term: Start date: 01-OCT-99 End date: 03-MAR-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Similkameen River tributary to the Kettle/Columbia River near Osoyoos.

Project Name: Chain Lake Chemical Rehabilitation
Description: Chemical rehabilitation of Chain Lake to eradicate Finescale suckers and Peamouth Chub, which will enhance the Rainbow trout fishery.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-81
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Other
Description: Chemical rehabilitation of Chain Lake to eradicate Finescale suckers and Peamouth Chub, which will enhance the Rainbow trout fishery.
Activity Term: Start date: 01-APR-81 End date:
Target Species: Rainbow Trout
Habitat(s): Lake
Location(s): Lake; Chain Lake, tributary to Hayes Creek, Similkameen/Okanagan/Columbia Rivers, west of Peachland.

Project Name: Allison Creek Fish Barrier Construction
Description: Construction of a coarse fish barrier to prevent the invasion of Bridgelip suckers, Longnose dace, and Torrent Sculpin in order to protect the productive Rainbow trout population.
Objective: Protect the productive Rainbow trout population in Allison Creek as part of the Habitat Conservation Trust Fund's (HCTF) overall objective to appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-84
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Other
Description: Construction of a coarse fish barrier to prevent the invasion of Bridgelip suckers, Longnose dace, and Torrent Sculpin.
Activity Term: Start date: 01-APR-84 End date:

Target Species: Rainbow Trout, Sculpins (General), Suckers (General)
Habitat(s): Stream
Location(s): Main Stem of Stream; Allison Creek, tributary to Similkameen/Okanagan/Columbia Rivers, north of Princeton.

Project Name: Rampart Dam Construction
Description: Construct an earth-fill dam with overflow spillway to increase Rainbow trout production. Also, provide access into the lake to adult trout.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Completed **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement **-** Barrier Modification / Obstruction Removal
Description: Construct an earth-fill dam with overflow spillway to increase Rainbow trout production. Also, provide access into the lake to adult trout.
Activity Term: Start date: 01-APR-89 End date:
Target Species: Rainbow Trout
Location(s): Lake; Rampart Lake tributary to Dry/Summers/Allison Creeks and Similkameen/Okanagan/Columbia.

Trepanier Creek

Trepanier Creek is considered to be a fourth order stream. It measures 28.3 km in length, and flows from the west to Okanagan Lake. Its confluence with Okanagan Lake is located just north of Peachland, BC.

Burbot, kokanee, prickly sculpin, rainbow trout, and suckers are fish species known to be present in Trepanier Creek. Rainbow trout at the eyed egg and fingerling life stage cycles have been stocked in Trepanier Creek by the Summerland Hatchery.

Table 47: Trepanier Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	DG		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	P1		
Large Woody Debris	DG		
Percent Pool	P1		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1		

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
<u>Stream Flow</u>			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		
<u>Stream Corridor</u>			
Riparian Vegetation	DG		
Stream Bank Stability	DG		
Floodplain Connectivity	P1		

Only 1.3 km of this stream is accessible to migratory trout and kokanee due to the presence of a series of bedrock and boulder chutes which culminate in a 12 m vertical irrigation dam. Approximately 75 percent of the total stream length downstream of the irrigation dam has been channelized. This channelization has reduced availability of holding pools for adult trout, and reduced the diversity of rearing niches for juveniles. Due to channelization of the lower reaches of this stream, spawning gravel for trout and kokanee have almost totally disappeared due to washout during spring freshets. The best rearing habitat is presently located in the first 100 m downstream of a series of cascades and chutes. Falls located approximately 3.2 km upstream of the confluence with Okanagan Lake are considered a barrier to the upstream migration of resident fish.

Urban development has significantly impacted Trepanier Creek. The stream has a critical water shortage problem that impedes its ability to meet fish production needs. Flows are restricted by Peachland District water use. There have been extended periods of time when the lower reaches of this system have dried up completely. If the low flow situation can be resolved satisfactorily, there is a site in the lower reaches of this stream where a small freshet-protected side channel might be constructed to provide a spawning refuge for the remaining kokanee attempting to persist in this stream.

The most notable industrial development in Trepanier Creek's headwaters is Brenda Mine. The water treatment plant constructed by the Noranda/Brenda Mines group has worked well in removing molybdenum from water collecting in an open pit. Release of treated water at low-flow periods in both the summer and winter could be highly beneficial to downstream fish stocks.

Although Trepanier Creek appears to support comparatively high production of trout and kokanee, additional licenses water withdrawal and periodic flood control measures resulting in channelization in its lower reaches threaten to reduce present level of recruitment to Okanagan Lake. An agreement with the District of Peachland and Brenda mines that would address the collective needs of all water users and fisheries requirements on both Trepanier and Peachland Creeks would be beneficial.

Projects Undertaken

Placement of spawning gravel for kokanee was conducted in the lower 1.1 km of Trepanier Creek. Kokanee habitat in Trepanier Creek is considered sensitive and must be protected.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Trepanier Creek Watershed Restoration Project
Description: Trepanier Creek watershed has an area of 255 sq. km. The watershed ranges in elevation from 342 m at Okanagan Lake to a max of 1,900 m at Mt Gottfriedsen. 60 percent of the watershed is above the 1,160 m elevation. The watershed is located on the eastern edge of the Thompson Highland physiographic division. Trepanier Creek watershed is a designated community watershed.
Objective: The focus of the Forest Renewal BC Watershed Restoration Program and this project is to accelerate the recovery of watersheds that have been adversely affected by resources extraction, particularly with respect to forestry.
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Restoration - Assessment & Planning
Description: This activity provides final watershed assessment committee recommendations. It also describes current watershed conditions, a risk assessment of proposed forest development, and conclusions regarding future watershed activity. Activity # 105256
Comment: Report Title: Watershed Assessment Report for the Trepanier Creek Watershed
Activity Term: Start date: 03-DEC-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Located within the Penticton Forest District.

Project Name: Peachland Creek and Trepanier Creek Watershed Restoration
Description: The Peachland and Trepanier Creeks lie within two adjacent watersheds and are located on the west side of Okanagan Lake by Peachland, BC. The Peachland Creek watershed is 14,150 ha in size and drains into Okanagan Lake approximately 3 km SW of Peachland. The Trepanier Creek watershed is 25,990 ha in size and also drains into Okanagan Lake at the North end of Peachland. There are approximately 543 km of roads in the watersheds. Both creeks flow approximately 25 km in an easterly direction from their headwaters to their confluences. Urbanization and agriculture occur along the lower 3 km of both watersheds. The Brenda Mine is located near the headwaters of both watersheds. Both watersheds are currently under forest licenses to Riverside Forest Products Limited, Gorman Brothers Lumber Ltd. and the Small Business Forest Enterprise Program.
Objective: This watershed will be assessed to determine what work will need to be completed in order to restore the areas that were damaged by past activities, such as logging.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: District of Peachland
Activity: Restoration - Overview Assessment
Description: The purpose of the Integrated Watershed Restoration Plan (IWRP) activity is to integrate the results of the Sediment Source Survey, Access Management Strategy, Fish Habitat Assessment Procedure and Interior Watershed Assessment Procedure (IWAP) to recommend an action plan for the prescription phase. The IWRP incorporates the results of the watershed-level and project planning objectives, as well as summarizing the existing conditions in the watershed and identifying significant problems associated with the roads and streams. It also provides a cost estimate and work schedule to complete prescription work. This procedure was completed within these watershed.
Comment: Report Title: Integrated Watershed Restoration Plan for the Peachland Creek & Trepanier Creek Watersheds Vol. 1 of 5 Percentage of Work Completed: Uncertain Informal Monitoring in Progress

Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Trepanier Creek, tributary to Okanagan Lake. Located just North of Peachland.
Activity: Restoration - Overview Assessment
Description: This activity outlines the results of the overview Sediment Source Survey work carried out as part of phase two of the Integrated Watershed Restoration Plan on the Peachland/ Trepanier watersheds.
Comment: Report Title: Sediment Source Survey Report for Peachland Creek & Trepanier Creek Watersheds Vol. 2 of 5 Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Trepanier Creek, tributary to Okanagan Lake. Located just North of Peachland.
Activity: Restoration - Overview Assessment
Description: Report type - Fish Habitat Assessment: This report contains an introduction to the study area with description, methodology section, extensive results and discussion section including fish habitat assessment and fish distribution assessment for both watersheds and a final recommendations section detailing each watershed. There are photos and many maps available.
Comment: Report title: Peachland/Trepanier Creek Watershed- Fisheries Habitat Assessment Procedure 1996 Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 29-MAY-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Trepanier Creek, tributary to Okanagan Lake. Located just North of Peachland.
Activity: Restoration - Overview Assessment
Description: Report type - Level 1 Coastal or Interior Watershed Assessment Procedure (CWAP or IWAP): This report contains an introduction and description, methods, results, conclusions and recommendations for both of the watersheds based on the assessment. There are many tables and appendices including Watershed Assessment Procedure Details, IWAP Report Cards and IWAP forms 1 to 9. There are maps that accompany the report in a separate tube.
Comment: Report title: Interior Watershed Assessment for the Peachland & Trepanier Creek Watersheds Vol. 5 of 5 Percentage of Work Completed: N/A Informal Monitoring in Progress
Activity Term: Start date: 01-SEP-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Trepanier Creek, tributary to Okanagan Lake. Located just North of Peachland.
Activity: Restoration - Overview Assessment
Description: Report type - Terrain Stability: This report contains sections with an introduction, methods, site description, surficial materials and associated landforms, active geomorphological processes and a discussion of terrain hazards. There is a 1:125,000 scale map and several photos that accompany the report.
Comment: Report title : Peachland and Trepanier Creek Stability Mapping Percentage of Work Completed: N/A Works done in 1998 and some informal monitoring in progress
Activity Term: Start date: 22-JAN-99 End date:
Habitat(s): Upslope
Location(s): Main Stem + Tributaries; Trepanier Creek, tributary to Okanagan Lake. Located just North of Peachland.

Project Name: Trout Creek Watershed Restoration Project
Description: Trout Creek watershed drains the Thompson Plateau on the west side of Okanagan Lake near Summerland. It encompasses an area of approx. 752 km with elevations ranging from 342 m to 1750 m. Timber harvesting has been carried out over the past 60 years.
Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Restoration - Overview Assessment
Description: Report type - Level 1 Coastal or Interior Watershed Assessment Procedure (CWAP or IWAP): This report contains the final watershed assessment committee recommendations. It also contains a section on current watershed conditions, risk assessment of proposed forest development and conclusions and recommendations. There are appendices containing Trepanier Creek and Trepanier Tributary Channels field forms and photos. Activity # 105256
Comment: Report title: Watershed Assessment Report for the Trepanier Creek Watershed Percentage of Work Completed: N/A Informal monitoring in progress
Activity Term: Start date: 03-DEC-98 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Trepanier Creek, tributary to Okanagan Lake. Located near Peachland.

Project Name: Nicola/Similkameen/Okanagan River Reconnaissance (1:20 000) Fish and Fish Habitat Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-99 End date:
Location(s): Main Stem + Tributaries; Trepanier Creek (including tributaries MacDonald/Jack Creeks), tributary to Okanagan Lake/Okanagan/Columbia Rivers, near Peachland.

Project Name: Trepanier Creek Watershed Stewardship Action Plan
Description: Stewardship/community planning; partnerships built with 11 groups/organizations.
Project Status: Active **Start Date:** 01-FEB-99 **End Date:** 31-MAR-00
Lead Proponent: Trepanier Creek Linear Park Society
Activity: Other - General
Description: Stewardship/community planning; partnerships built with 11 groups/organizations.
Activity Term: Start date: 01-FEB-99 End date: 31-MAR-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Trepanier Creek tributary to Okanagan Lake/Okanagan/Columbia River near Peachland.

Project Name: Trepanier Creek Spawning Channel: Watershed Concerns
Description: Preliminary evaluation of a proposed spawning channel. Developed recommendations for four issues (low flows; sedimentation from the Macdonald Creek landslide; municipal issues and public/input stewardship) that may have an impact on the proposed spawning channel and fish habitat.
Project Status: Active **Start Date:** 01-SEP-99 **End Date:** 15-DEC-99
Lead Proponent: Trepanier Creek Linear Park Society
Activity: Restoration - Assessment & Planning
Description: A preliminary engineering evaluation of proposed spawning channel was completed. This evaluation will lead to stewardship and community planning regarding the following issues: low flows, sedimentation from the MacDonald landslide and municipal issues, all which would impact the proposed channel.
Activity Term: Start date: 01-SEP-99 End date: 15-DEC-99
Location(s):
Location(s): Main Stem of Stream; Trepanier Creek, tributary to Kootenay Lake, Kootenay/Columbia Rivers, near Peachland.

Project Name: Trepanier Ditch Upgrade
Description: The Trepanier ditch water system upgraded to a pressurized system to contribute to upgrading the multi-user ditch system.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Water Quality
Description: Upgrade the Trepanier ditch water system to a pressurized system to contribute to upgrading the multi-user ditch system.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Trepanier Creek (alias Trepanier Ditch), tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Peachland.

Trout Creek

Trout Creek is a fourth order stream that measures 80.1 km in length. This system flows from the west, and enters Okanagan Lake just south of Summerland, BC. The watershed area is approximately 150,000 hectares, and is very dry due to limited summer rainfall.

The Trout Creek watershed has been extensively altered by agriculture, urban development, and timber harvesting. This alteration has resulted in varying degrees of degradation, ranging from partial habitat degradation to complete elimination.

The watershed is located in several Biogeoclimatic zones that range from Engelman spruce and subalpine fir at the headwaters to Montane spruce, Interior Douglas-Fir to ponderosa pine and bunch grass at Okanagan Lake.

Agricultural and rangeland activities occur throughout the watershed, as do logging activities.

Fish species present in Trout Creek include brook trout, kokanee, largescale sucker, longnose dace, mountain whitefish, peamouth chub, prickly dculpin, and rainbow trout. The Summerland Hatchery has also stocked Trout Creek with brook trout at the eyed egg life cycle stage.

Table 48: Trout Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered			
Water Quality			
Dissolved Oxygen	DG		
Stream Temperature	DG		
Turbidity/Suspended Sediment	P1		
Nutrient Loading	DG		
In Channel Habitat			
Fine Sediment (substrate)	P1		
Large Woody Debris	DG		
Percent Pool	DG		
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P1		
Stream Flow			
Resembles Natural Hydrograph	P1		
Impervious Surface	DG		
Stream Corridor			
Riparian Vegetation	DG		
Stream Bank Stability	DG		
Floodplain Connectivity	P1		

Habitat does not appear to be conducive to kokanee production, primarily because the substrate is predominately large and heavily silted. Most kokanee spawning associated with Trout Creek occurs at or near the mouth of the stream.

Water clarity in lower Trout Creek is affected by high levels of suspended solids entering the stream via a large slide located nearly 4.4 km upstream of the confluence with Okanagan Lake. This major slide zone along the creek requires stabilization.

The elevation range of Trout Creek is from 342 m at the confluence to over 1920 m at the headwaters. A 2.5 m high falls and canyon located approximately 2.4 km upstream of the confluence with Okanagan Lake prevents upstream migration of kokanee. Downstream of the canyon the stream has been subjected to severe channelization and bank armoring for flood control. This practice has largely destroyed residual habitat qualities associated with trout and kokanee production.

A series of dams constructed on Trout Creek also represent fish migration barriers. Approximately 2 km upstream of Okanagan Lake a low-head irrigation diversion dam spans the stream at the lower extremity of the Trout Creek Canyon. This dam is about 2.0 – 2.2 m in height. It is likely passable to larger trout in the spring, but a complete barrier to kokanee in the fall. Approximately 0.8 km upstream of the first diversion dam (and still located within the canyon) is a natural obstruction reported to be just over 2 m in height. Another diversion and reservoir dam constructed and operated by Summerland Irrigation District to provide the town of Summerland with ample water supply is located 14 km upstream of Okanagan Lake.

Stream flows in Trout Creek are very low. Fish will likely get trapped in the flats and perish as the water flow continues to recede. There is a channel that diverts Trout Creek water to a reservoir that is used as water supply for the town of Summerland.

Projects undertaken

A Water Survey of Canada station collects water quality and quantity data for Trout Creek.

In 1995 a Trout Creek watershed restoration project was undertaken by the District of Summerland through Forest Renewal BC in conjunction with several other groups and agencies. Potential habitat restoration options for the most affected reaches of Trout Creek included re-establishment of a meandering stream channel, installation of in-stream structures to replace lost features, excavation of a new flow channel to replace lost habitat while retaining existing channel for flood control purposes, and the creation of a groundwater fed spawning channel for kokanee. Protection of spawning habitat should be made a priority in this watershed.

The mainstem and many lakes throughout the watershed provide recreational sites.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Trout & Eneas Creek Watershed Restoration
Description: The Trout Creek watershed drains the Thompson Plateau on the west side of Okanagan Lake near Summerland. The watershed is 744 sq. km in size and ranges from 342 m to 1920 m.
Objective: This watershed will be assessed to determine what work will need to be completed in order to restore the areas that were damaged by past activities, such as logging.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: District of Summerland
Activity: Restoration - Overview Assessment
Description: For this activity an Interior Watershed Assessment Procedure (IWAP) was conducted, assessing the entire watershed including roads, gullies and streams. The current watershed conditions were detailed and recommendations were made based on the assessment as to what work should be completed in the future to restore the watershed.
Comment: Report Title: Interior Watershed Assessment for the Trout Creek Watershed Percentage of Work Completed: None Informal Monitoring in Progress
Activity Term: Start date: 01-JUL-96 End date:
Habitat(s): Upslope

Location(s): Watershed; Trout Creek, tributary to Okanagan Lake. Located ~ 20-30 km North of Penticton.
Activity: Restoration - Overview Assessment
Description: For this activity an Integrated Watershed Restoration Plan was conducted. The objectives were defined and a summary of findings and recommendations were issued. It contains a Fish Habitat Assessment Procedure, Sediment Source Survey and Access Management Map.
Comment: Report Title: Trout and Eneas Creek Integrated Watershed Restoration Plan Percentage of Work Completed: None Informal Monitoring in Progress
Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Trout Creek, tributary to Okanagan Lake. Located ~20-30 km North of Penticton.

Project Name: Trout Creek Watershed Restoration Project
Description: Trout Creek watershed drains the Thompson Plateau on the west side of Okanagan Lake near Summerland. It encompasses an area of approx. 752 km with elevations ranging from 342 m to 1750 m. Timber harvesting has been carried out over the past 60 years.
Objective: The objectives of this project are to protect, restore and rehabilitate fisheries, aquatic and forest resources that have been adversely impacted by past disturbances such as logging, mining and road construction within this watershed.
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Restoration - Overview Assessment
Description: An Interior Watershed Assessment Procedure for Trout Creek Watershed was conducted. The activity report includes: Introduction, key watershed assessment issues, watershed characteristics, methods, results of office analysis, results of past assessments and reports, risk of future forest development, conclusions and recommendations. These are the final watershed assessment committee recommendations. Appendices include: Maps, Equivalent Cut Area (ECA) Tables, and meeting minutes.
Comment: Report Title: Interior Watershed Assessment Procedure for Trout Creek Watershed (Update Report) Percentage of Work Completed: N/A Works done in 1998 and 1999 and some informal monitoring in progress
Activity Term: Start date: 01-DEC-98 End date:
Habitat(s): Stream
Location(s): Watershed; Trout Creek, tributary to the Okanagan River. Located in Summerland.
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This activity produced prescriptions for the priority sites noted in contract # DPE-WRP-98-GORMANS-1 in the Trout Creek Watershed. Appendices include: Location maps, table 1`s, and keys to codes in tables.
Comment: Report Title: Major Works Prescriptions for Priority Sites in Trout Creek Watershed Percentage of Work Completed: Uncertain Informal monitoring in progress
Activity Term: Start date: 01-SEP-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Trout Creek, tributary to the Okanagan River. Located in Summerland.
Activity: Restoration - Upslope Restoration / Rehabilitation
Description: Road deactivation work was undertaken in the Trout Creek watershed. The objective of the work is to minimize the risk of sediment transport and surface erosion from the selected road. Appendices of activity report include: Location Map, equipment supervision summary and photo documentation.

Comment: Report Title: Results of Road Deactivation for Priority Sites in Trout Creek Watershed Percentage of Work Completed: Uncertain Informal monitoring in progress
Activity Term: Start date: 01-DEC-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Trout Creek, tributary to the Okanagan River. Located in Summerland.
Activity: Restoration - Effectiveness Monitoring & Evaluation
Description: Report type - Monitoring & Evaluation-In Stream: The primary goal of the 1996 water quality program was to establish benchmark data at four locations to determine current water quality conditions. The report contains: Objectives, Methods, Results (Water temp., Apparent Color, Turbidity, Phosphate, Nitrate, Ammonia, Conductivity, Hardness, pH, Coliform, Discharge), and Recommendations/Conclusions.
Comment: Report title: Water Quality Monitoring Program for the Trout Creek Watershed Percentage of Work Completed: N/A
Activity Term: Start date: 01-OCT-96 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Trout Creek, tributary to the Okanagan River. Located in Summerland.
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This report contains a general introduction, Isintok Creek subbasin section, Eastmere/Spring Creek Small Business Forest Enterprise Program (SBFEP) chart area, Glen Lake SBFEP chart area, Gorman Bros. Operating area, sediment source survey site #10 and summary and recommendations. There are photos in the report and several maps.
Comment: Report Title: Trout Creek Field Prescription and Implementation Monitoring Report Percentage of Work Completed: Uncertain Informal Monitoring in Progress
Activity Term: Start date: 01-DEC-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Trout Creek, tributary to the Okanagan River. Located in Summerland.

Project Name: Nicola/Similkameen/Okanagan River Reconnaissance (1:20 000) Fish and Fish Habitat Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Gorman Brothers Lumber Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-99 End date:
Location(s): Main Stem + Tributaries; Trout Creek (including tributaries Darke/Liddel/Isintok/Bearpaw/Lost Chain/Rowley/Thirsk/Fenton/Bull/Kirton/Camp/Kathleen Creeks), tributary to Okanagan Lake/Okanagan/Columbia Rivers, south of Summerland.

Project Name: Trout Creek Intake Fish Screen
Description: Design, construction, installation and maintenance of a self cleaning fish screen, located immediately downstream of the diversion intake into the municipal water system.
Objective: Reduce fish mortalities.

Project Status: Active **Start Date:** 01-AUG-99 **End Date:** 31-MAY-00
Lead Proponent: District of Summerland
Activity: Restoration - Restore Fish Passage
Description: Design, construction, installation and maintenance of a self cleaning fish screen, located immediately downstream of the diversion intake into the municipal water system.
Activity Term: Start date: 01-AUG-99 End date: 31-MAY-00
Target Species: All species
Habitat(s): Stream
Location(s): Main Stem of Stream; Trout Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Summerland.

Vaseux Creek

Vaseux Creek flows directly to Okanagan Lake from the east. It is a fourth order stream that measures 34.8 km in length.

Fish species known to be present in Vaseux Creek include bridgelip sucker, longnose dace, mountain whitefish, prickly sculpin, rainbow trout, and sockeye salmon.

Table 49: Vaseux Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Alluvial fan	Canyon at 3km u/s of confluence	Falls at 5.5km u/s of confluence
Water Quality			
Dissolved Oxygen	DG	DG	DG
Stream Temperature	P2	DG	DG
Turbidity/Suspended Sediment	P1	DG	DG
Nutrient Loading	DG	DG	DG
In Channel Habitat			
Fine Sediment (substrate)	DG	DG	DG
Large Woody Debris	P2	DG	DG
Percent Pool	DG	DG	DG
≤ 2%			
2-5%			
>5%			
Habitat Access			
Fish Passage	P2	DG	DG
Stream Flow			
Resembles Natural Hydrograph	P2	DG	DG
Impervious Surface	DG	DG	DG
Stream Corridor			
Riparian Vegetation	P2	F2	G2
Stream Bank Stability	F2	DG	DG
Floodplain Connectivity	P2	DG	DG

Gravel beds present are considered to be suitable for trout spawning. However, water quality as well as quantity are issues in Vaseux Creek. The ephemeral nature of the stream would limit fish access and may strand emerging fry.

The riparian condition is poor in the lower reaches of the stream. During sudden flash flood events debris is washed into the stream and transported downstream to lower accessible reaches, limiting fish use. A flume dam has been constructed on this creek, exacerbating conditions during flash flood events. Riparian condition upstream of this point is unknown at this time.

A series of falls and pools are located approximately 5.8 km upstream of the confluence to Okanagan Lake. One fall is 2 m and the other is 2.6 m in height. Fish would have difficulty mounting these falls, thus limiting upstream migration.

Projects Undertaken

Extensive electrofishing has been conducted in Vaseux Creek for fish population assessment purposes.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Hedley / McNulty / Cahill / Winters Creek Watershed Restoration
Description: Part of Forest Renewal British Columbia's Watershed Restoration Program, the study area contains the Hedley / McNulty Creek Watershed, the Cahill Creek Watershed and Winters Creek Watershed that together have an area of about 600 sq. km. The study area is located on the Thompson Plateau northeast of the town of Hedley, and north of the Similkameen River valley and Highway 3 between Princeton and Keremeos in southern BC
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and road construction.
Project Status: Active **Start Date:** 01-APR-95
Lead Proponent: Weyerhaeuser Canada Limited
Activity: Restoration - Overview Assessment
Description: This report includes: Introduction, overview, objectives, methodology, results and conclusions. The objective of the Access Management Strategies (AMS) is to propose changes to the road system that will reduce the risk of environmental damage, particularly sediment delivery to streams while still maintaining the access into the watershed for the various stakeholders and watershed users. Appendices include: Definition of Road Deactivation Levels, Stakeholders and Resource Users Contact list and Comments, Land Tenure and Permit Status List and Maps.
Comment: Report Title: Access Management Strategies (AMS) for Shuttleworth and Vaseux Creek Watersheds (Vol. 3 of 5) Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Vaseux Creek, tributary to the Okanagan Lake. Located just North of Oliver.
Activity: Restoration - Overview Assessment
Description: This report includes: Introduction, types of overview assessments conducted, summary of existing watershed conditions, prescription phase of the Interior Watershed Restoration Plan (IWRP), problems requiring prescription work, priority list, time and cost

estimates, and recommendations. Appendices include an overview map and timing of prescription work.
Comment: Report Title: Integrated Watershed Restoration Plan (IWRP) for Shuttleworth and Vaseux Creek Watersheds (Vol. 1 of 5) Percentage of Work Completed: Uncertain Informal Monitoring in progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Stream, Upslope
Location(s): Watershed; Vaseux Creek, tributary to the Okanagan Lake. Located just North of Oliver.
Activity: Restoration - Overview Assessment
Description: Both watersheds located in the Okanagan highlands region southeast of Okanagan and Vaseux Lakes cover 379 sq. km. This report includes: Introduction, methods, watershed characteristics, results, conclusions and recommendations. Appendices include: Watershed Assessment Procedure Details, Interior Watershed Assessment Procedure (IWAP) Report Cards, IWAP Forms, and Roundtable Meeting Minutes. Maps are available in separate map tubes.
Comment: Report Title: Interior Watershed Assessment for Shuttleworth Creek and Vaseux Creek Watersheds (Vol. 5 of 5) Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Vaseux Creek, tributary to the Okanagan Lake. Located just North of Oliver.
Activity: Restoration - Overview Assessment
Description: The objective of this report was to identify all unstable or potentially unstable land areas at a mapping scale of 1:20,000 for the total watershed area of 37,767 ha. The report discusses methods and results of the terrain stability mapping which involved a Terrain Survey Intensity Level D Analysis and an assessment of the potential effects of conventional forest harvesting on terrain stability. Photo documentation is also available.
Comment: Report Title: Reconnaissance Terrain Stability Mapping of Vaseux Creek and Shuttleworth Creek Watersheds Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-MAR-99 End date:
Habitat(s): Upslope
Location(s): Watershed; Vaseux Creek, tributary to the Okanagan Lake. Located just North of Oliver.
Activity: Restoration - Overview Assessment
Description: The main objectives of this Sediment Source Survey (SSS) were: To review all roads corridors, hillslopes and gullies within both watersheds, to determine eligibility for restoration funding, to identify and inventory sites of road related mass wasting/surface erosion/stream sedimentation hazards and to confirm priority areas for future prescription work. The report includes: Introduction, objectives, methodology, assessment results, planning and scheduling for prescription phase, conclusions and recommendations.
Comment: Report Title: Sediment Source Survey (SSS) Report for Shuttleworth and Vaseux Creek Watershed (Vol. 2 of 5) Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-FEB-98 End date:
Habitat(s): Upslope

Location(s): Watershed; Vaseux Creek, tributary to the Okanagan Lake. Located just North of Oliver.
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This report contains the prescriptions for the priority sites noted in Contract #98-WRP-Prescriptions for the Penticton, Shuttleworth, and Vaseux Watersheds. Also included are the prescriptions for Priority site `S1I` and Road #1603.
Comment: Report Title: Upslope Prescriptions for the Priority Sites in the Penticton Creek, Shuttleworth Creek and Vaseux Creek Watersheds. Percentage of Work Completed: Uncertain Works done in 1999 and some informal monitoring in progress
Activity Term: Start date: 01-SEP-98 End date:
Habitat(s): Upslope
Location(s): Watershed; Vaseux Creek, tributary to the Okanagan Lake. Located just North of Oliver.
Activity: Restoration - Overview Assessment
Description: The study area is located approx. 10 km south of Penticton where it drains into the Okanagan River. The report includes: Background information, methodology, results and discussion, and recommendations. Appendices include: fish distribution forms, habitat condition data forms, preliminary habitat forms and many maps. A short section of photos is also included.
Comment: Report Title: Vaseux Creek Watershed Fisheries Habitat Assessment Procedure Percentage of Work Completed: N/A Informal Monitoring in progress
Activity Term: Start date: 01-MAY-97 End date:
Habitat(s): Stream
Location(s): Watershed; Vaseux Creek, tributary to the Okanagan Lake. Located just North of Oliver.

Project Name: Weyerhaeuser-OK Falls Div.-Multi-Year Plan (1998) 1:20K Reconnaissance Fish and Fish Habitat Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to Resource Inventory Committee (RIC) standards
Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics.
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: Weyerhaeuser Canada Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-98 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Un-named creek (alias Angel Creek), WS Code: 310-522400-66300, tributary to Vaseux Creek, tributary to Okanagan/Columbia Rivers, near Okanagan Falls; Dutton Creek, tributary to Vaseux Creek, tributary to Okanagan/Columbia Rivers, near Okanagan Falls; McIntyre Creek, tributary to Vaseux Creek, tributary to Okanagan/Columbia Rivers, near Okanagan Falls; Solco Creek, tributary to Vaseux Creek, tributary to Okanagan/Columbia Rivers, near Okanagan Falls; Underdown Creek, tributary to Vaseux Creek, tributary to Okanagan/Columbia Rivers, near Okanagan Falls.

Project Name: Okanagan Falls Reconnaissance (1:20,000) Stream Inventory
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory, performed according to Resource Inventory Committee (RIC) standards

Objective: A sample based survey covering whole watersheds, providing information regarding fish species distributions, characteristics and relative abundance, and stream reach and lake biophysical characteristics
Project Status: Active **Start Date:** 01-APR-97
Lead Proponent: Weyerhaeuser Canada Limited
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-97 End date:
Location(s): Main Stem + Tributaries; Unnamed Creek (alias Angel Creek), WS Code: 310-444700-66300, tributary to Vaseux Creek, Okanagan/Columbia Rivers, near Oliver; Dutton Creek, tributary to Vaseux Creek, Okanagan/Columbia Rivers, near Oliver; McIntyre Creek, tributary to Vaseux Creek, Okanagan/Columbia Rivers, near Oliver; Solco Creek, tributary to Vaseux Creek, Okanagan/Columbia Rivers, near Oliver; Underdown Creek, tributary to Vaseux Creek, Okanagan/Columbia Rivers, near Oliver.

Vernon Creek

Vernon Creek enters Okanagan Lake west and slightly south of Vernon city limits. It is a fifth order stream that measures 36.1 km in length. The stream drains through a series of lakes, and is the principal outlet of Kalamalka Lake. The system can be readily divided into two distinct reaches or zones with the separating boundary located at Polson Park in downtown Vernon.

Agricultural and rangeland activities occur throughout the watershed, and include ranches located in the Winfield area.

Known fish present in Vernon Creek includes burbot, carp, kokanee, northern pikeminnow (formerly n. squawfish), prickly sculpin, rainbow trout, redside shiner, sculpins, and suckers. Fish stocking of kokanee fry has occurred in Vernon Creek by the Skaha Hatchery.

Table 50: Vernon Creek Limiting Factors Matrix

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to Polson Park, Vernon	U/s of Polson Park, Vernon	
Water Quality			
Dissolved Oxygen	DG	F2	
Stream Temperature	DG	DG	
Turbidity/Suspended Sediment	P1	F1	
Nutrient Loading	P1	F1	
In Channel Habitat			
Fine Sediment (substrate)	DG	P1	
Large Woody Debris	DG	DG	
Percent Pool ≤ 2% 2-5% >5%	DG	P1	

Reach break description	Reach 1	Reach 2	Reach 3
Attribute Considered	Confluence to Polson Park, Vernon	U/s of Polson Park, Vernon	
Habitat Access			
Fish Passage	P1	DG	
Stream Flow			
Resembles Natural Hydrograph	P1	DG	
Impervious Surface	DG	DG	
Stream Corridor			
Riparian Vegetation	DG	DG	
Stream Bank Stability	DG	DG	
Floodplain Connectivity	DG	DG	

Salmonid production is limited in Vernon Creek by poor water quality, disturbance to rearing habitat, and seasonal low flows. Downstream of Polson Park the water quality and productive habitat for salmonids rapidly deteriorates. Storm water discharge is also impacting water quality and is especially evident in the lower reaches of Vernon Creek as substrate embeddedness. Upstream of Polson Park the water quality is better, although habitat is generally unfavorable for good salmonid production. Pools are very scarce at discharge of less than 2.0 – 2.8 cubic m per second. The reach between Kalamalka Lake and Polson Park appears as a series of fast moving runs and riffles at this flow.

The most productive habitat appears to be a section extending approximately 0.5 km downstream of Kalamalka Lake proper. Kokanee were observed spawning here in October 1976 (most likely outlet spawners from Kalamalka Lake); it is unclear if they have spawned at this location since then. Cover, water velocity, and substrate characteristics appear compatible with trout spawning as well.

Water quality has also been degraded by a variety of waste products, including at one time treated sewage from the city's treatment plant. The impact of spray irrigation on groundwater quality and Lower Vernon Creek water quality should be investigated. While elevated levels of phosphorous have historically been found in well samples, it is not known if the nutrients are passing through to surface waters.

Vernon Creek is also subject to seasonal low flows, predominantly in the fall. A distillery had previously released water into the creek. However, this distillery no longer releases outfall into this section, and thus flows are lower than historical regimes. Water withdrawal from area ranches for irrigation purposes has exacerbated low flow conditions.

A large, flat-bottomed culvert located at the Okanagan Landing Road crossing of Vernon Creek approximately 1.5 km upstream of the lake is thought to be impassable to kokanee in the fall. It is difficult for trout to migrate upstream in the spring as well. The culvert is also a complete barrier to spawning coarse fish species from Okanagan Lake.

Incidental kokanee ascent further upstream from this point would be hampered by a series of culverted residential road crossings. Also, a beaver dam blocks the outlet of Minn Lake. This dam is considered to be a barrier to fish migration.

Several suggestions have been made to further enhance the fish habitat quality in Vernon Creek. Annual gravel placement by hand would benefit both kokanee and rainbow trout spawning. The placement of boulder clusters in association with large woody debris would provide fish refuge sites. Stream bank stabilization and replanting of disturbed stream side areas with native plants to limit silt deposition. The removal of man-made debris and removal of beavers to prevent additional dam construction would also facilitate improved recruitment to Okanagan Lake.

Projects Undertaken

Several enhancement projects have occurred in the Vernon Creek Watershed. Gravel was placed to enhance spawning and egg incubation potential. Riprap was added at the bottom of Wood Lake Road to stabilize stream banks in this section. A debris jam was removed on upper Vernon Creek. Bank stabilization and creek bed widening was undertaken to increase habitat potential. Also the placement of weirs and gravel was conducted within Polson Park to create spawning platforms for kokanee.

A Water Survey of Canada station was located on Vernon Creek in 1973 to collect data on water quality and quantity in the creek.

Other fish and fish habitat projects undertaken in the watershed include:

Project Name: Vernon/Winfield Creeks Stewardship Action Plan
Description: Habitat assessment, inventory and mapping for 6km.
Project Status: Active **Start Date:** 01-FEB-00 **End Date:** 31-MAR-00
Lead Proponent: Oceola Fish and Game Club
Activity: Inventory - Mapping
Description: Inventory and mapping for 6km.
Activity Term: Start date: 01-FEB-99 End date: 31-MAR-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Vernon Creek tributary to Okanagan Lake/Okanagan/Columbia River.

Project Name: Oyama Creek Watershed Restoration
Description: The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the eastern corner of the Thompson Plateau. The watershed has an area of 4 400ha. This watershed supplies both domestic and irrigation water to the Wood Lake Improvement District.
Objective: The objectives of this project are to restore the watershed to some level of pre harvest condition, to restore natural hydrology to the area, and to enhance and rehabilitate riparian habitat. Specific actions undertaken may be road deactivation, gully and landslide rehabilitation and sediment source detection.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Wood Lake Improvement District
Activity: Restoration - Overview Assessment

Description: This activity report outlines the access management strategy for the Oyama Creek Watershed. The objective of this report was to identify the long term access requirements for the current roads in the watersheds and determine an appropriate level of deactivation, based on road use that will reduce environmental impacts, particularly sediment delivery to streams. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the eastern corner of the Thompson Plateau. This watershed supplies both domestic and irrigation water to the Wood Lake Improvement District.
Comment: Report Title: Access Management Strategy for the Oyama Creek Watershed (Volume 1 of 1) Percentage of Work Completed: N/A All high priority works completed.
Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Upslope
Location(s): Watershed; The watershed is located in south central BC, in the Kal-Wood/Okanagan drainage basin. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the eastern corner of the Thompson Plateau. Oyama WSC: 310-939400-34700
Activity: Restoration - Overview Assessment
Description: This activity report outlines the integrated watershed restoration plan for the Oyama Creek watershed. The purpose of this report is to integrate the results of the sediment source survey, access management strategy, fish habitat assessment procedure, channel assessment procedure and interior watershed assessment procedure completed in the watershed. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the eastern corner of the Thompson Plateau. The watershed has an area of 4,400 ha. This watershed supplies both domestic and irrigation water to the Wood Lake Improvement District.
Comment: Report Title: Oyama Creek Watershed: Results of the Watershed Restoration Project Percentage of Work Completed: Uncertain All high priority works completed.
Activity Term: Start date: 01-MAR-96 End date:
Habitat(s): Stream, Upslope
Location(s): Watershed; The watershed is located in south central BC, in the Kal-Wood/Okanagan drainage basin. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the eastern corner of the Thompson Plateau. Oyama WSC: 310-939400-34700
Activity: Restoration - Upslope Restoration / Rehabilitation
Description: This report outlines the road design for the Oyama Creek Watershed. The objective of this report was to present the road alignments, volume estimates and construction considerations for approximately 1.7 km of proposed road upgrade of the Oyama Lake Road. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the Eastern corner of the Thompson Plateau. The watershed has an area of 4,400 ha. This watershed supplies both domestic and irrigation water to the Wood Lake Improvement District.
Comment: Report Title: Oyama Creek Road Design Percentage of Work Completed: 100 percent All high priority works completed.
Activity Term: Start date: 07-NOV-97 End date:
Habitat(s): Upslope
Location(s): Watershed; The watershed is located in south central BC, in the Kal-Wood/Okanagan drainage basin. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the eastern corner of the Thompson Plateau. Oyama WSC: 310-939400-34700
Activity: Restoration - Overview Assessment
Description: This activity report outlines the results of the interior watershed assessment procedure conducted on the Oyama Creek Watershed. The objectives of this report were to document watershed characteristics and conditions, and to determine the potential for cumulative hydrologic impacts that may be associated with past forest development in the watersheds. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the

Easter corner of the Thompson Plateau. The watershed has an area of 4,400 ha. This watershed supplies both domestic and irrigation water to the Wood Lake Improvement District.
Comment: Report Title: Interior Watershed Assessment for the Oyama Creek Watershed Percentage of Work Completed: N/A All high priority works completed.
Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Upslope
Location(s): Watershed; The watershed is located in south central BC, in the Kal-Wood/Okanagan drainage basin. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the eastern corner of the Thompson Plateau. Oyama WSC: 310-939400-34700
Activity: Restoration **-** Effectiveness Monitoring & Evaluation
Description: This activity report outlines the water quality monitoring which was conducted for the Oyama Creek watershed. The objectives of this report were to provide baseline water quality data and document any changes that may occur as a result of timber harvesting or other activities. The Oyama Creek watershed has a drainage area of about 40 sq. km. The watershed is located in south central BC In the Kal-Wood/Okanagan drainage basin.
Comment: Report Title: Oyama Creek Watershed Water Quality Monitoring Percentage of Work Completed: N/A All high priority works completed
Activity Term: Start date: 01-MAR-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; The watershed is located in south central BC, in the Kal-Wood/Okanagan drainage basin. The Oyama Creek watershed is located on the south east side of Kalamalka Lake, near Oyama on the eastern corner of the Thompson Plateau. Oyama WSC: 310-939400-34700.

Project Name: Vernon Creek Watershed Restoration
Description: Vernon Creek is the community watershed for the town of Winfield. Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield.
Objective: The objectives of this project are to restore the watershed to some level of pre harvest condition, to restore natural hydrology to the area, and to enhance and rehabilitate riparian habitat. Specific actions undertaken may be road deactivation, gully and landslide rehabilitation and sediment source detection.
Project Status: Active **Start Date:** 01-APR-95
Lead Proponent: Winfield and Okanagan Centre Irrigation District
Activity: Restoration **-** Upslope Restoration / Rehabilitation
Description: This activity report describes the restoration work completed on landslide #16 in the Vernon Creek watershed during 1997. The landslide took place on May 16, 1997. The restoration program consisted of emergency erosion control, engineering, logistical planning and site works. Vernon Creek is the community watershed for the town of Winfield. Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield.
Comment: Report Title: Landslide Restoration Works on Landslide #16, Vernon Creek Fall 1997 Percentage of Work Completed: Uncertain
Activity Term: Start date: 21-DEC-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield, BC It flows west through a chain of lakes before descending into the Okanagan Valley at Winfield. Vernon Creek: 310-939400
Activity: Restoration **-** Overview Assessment
Description: This report outlines the landslide rehabilitation assessment procedure conducted in the Vernon Creek watershed. The objectives of this report were to reduce erosion and improve site

stability, minimize sediment delivery off site and allow for revegetation, as well as mitigate visual impacts and initiate and enhance natural rehabilitation processes. Vernon Creek is the community watershed for the town of Winfield. Vernon Creek originates in the Thompson Plateau about 22km northeast of Winfield.
Comment: Report Title: Vernon Creek Watershed Landslide Rehabilitation Assessment Procedure Percentage of Work Completed: N/A
Activity Term: Start date: 30-SEP-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield, BC It flows west through a chain of lakes before descending into the Okanagan Valley at Winfield. Vernon Creek: 310-939400
Activity: Restoration - Overview Assessment
Description: This report outlines the sediment source survey conducted for the Vernon Creek Watershed. The objectives of this report were to review all road corridors, hillslopes and gullies within the watersheds and determine eligibility for restoration funding; and identify and inventory sites of road related mass wasting, surface erosion and stream sedimentation hazards, as well as confirm priority areas for future prescription work. This report summarizes the stream channel assessment work carried out in the Vernon Creek Watershed. The purpose of the channel assessment procedure was to identify significant changes to stream channels that appear to be the result of past logging activities, and to develop recommendations for restoration work. Vernon Creek is the community watershed for the town of Winfield. Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield.
Comment: Report Title: Stream Channel Assessment and Sediment Source Survey: Vernon Creek Watershed Percentage of Work Completed: N/A
Activity Term: Start date: 01-APR-97 End date:
Habitat(s): Upslope
Location(s): Watershed; Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield, BC It flows west through a chain of lakes before descending into the Okanagan Valley at Winfield. Vernon Creek: 310-939400
Activity: Restoration - Overview Assessment
Description: This activity report details the stream channel assessment, sediment source survey and water quality monitoring program carried out in the Vernon Creek Watershed. The objectives of the stream channel assessment were to: - review aerial photos of the Vernon Creek system to identify any changes in channel characteristics and evaluate channel sensitivity; - complete field assessments to determine if past forestry activities have caused channel impacts, focusing on potential impacts identified by the Level I Interior Watershed Assessment Procedure (IWAP) analysis and the review of aerial photos; - identify any sites on the stream channel which have been impacted by forestry activities; - identify the need for detailed prescriptions for site restoration, as needed, and; - comment on possible effects of future harvest on the stream channel. The objectives of the Sediment Source Survey were to: - complete a Level I road condition assessment; - complete an inventory of existing landslides, gullies and other sources of sediment to the stream network and; - make recommendations on which sources require additional assessment in order to develop restoration prescriptions.
Comment: Report Title: Stream Channel Assessment and Sediment Source Survey: Vernon Creek Watershed Percentage of Work Completed: N/A
Activity Term: Start date: 01-APR-97 End date:
Habitat(s): Upslope
Location(s): Main Stem + Tributaries; Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield, BC It flows west through a chain of lakes before descending into the

Okanagan Valley at Winfield. Vernon Creek: 310-939400
Activity: Restoration - Overview Assessment
Description: This activity report outlines the access management strategy for the Vernon Creek Watershed. The objective of this report was to identify the long term access requirements for the current roads in the watersheds and determine an appropriate level of deactivation, based on road use that will reduce environmental impacts, particularly sediment delivery to streams. Vernon Creek is the community watershed for the town of Winfield. Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield.
Comment: Report Title: Vernon Creek Watershed Access Management Strategy Percentage of Work Completed: N/A
Activity Term: Start date: 01-MAR-99 End date:
Habitat(s): Upslope
Location(s): Watershed; Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield, BC It flows west through a chain of lakes before descending into the Okanagan Valley at Winfield. Vernon Creek: 310-939400
Activity: Restoration - Effectiveness Monitoring & Evaluation
Description: Interim reports were submitted in July, September and November 1996 and March 1997. This is the final report. The general objective of this study was to measure water quality at specific locations within the Vernon Creek watershed to serve as baseline data for monitoring the effects of future watershed restorative activities.
Comment: Report Title: Vernon Creek: Water Quality Monitoring Report 1996-97 Percentage of Work Completed: N/A
Activity Term: Start date: 11-JUL-97 End date:
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Vernon Creek originates in the Thompson Plateau about 22 km northeast of Winfield, BC It flows west through a chain of lakes before descending into the Okanagan Valley at Winfield. Vernon Creek: 310-939400.

Project Name: King Edward Lake Watershed Restoration
Description: King Edward Creek (known locally as Deer Creek) originates on the Thompson Okanagan Plateau in the southern interior approximately 15 km southeast of the community of Vernon, and is a tributary of Coldstream Creek. The two creeks meet about 5 km upstream of the outlet to Kalamalka Lake.
Objective: The objectives of this project are to restore the watershed to some level of pre harvest condition, to restore natural hydrology to the area, and to enhance and rehabilitate riparian habitat. Specific actions undertaken may be road deactivation, gully and landslide rehabilitation and sediment source detection.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: Tolko Industries Limited
Activity: Restoration - Detailed Assessments and Prescriptions
Description: This report outlines the integrated watershed restoration plan for the King Edward Creek Watershed. The purpose of this report is to integrate the results of the sediment source survey, access management strategy, fish habitat assessment procedure, channel assessment procedure and interior watershed assessment procedure completed in the watersheds. King Edward Creek (known locally as Deer Creek) originates on the Thompson Okanagan Plateau in the southern interior approximately 15 km southeast of the community of Vernon, and is a tributary of Coldstream Creek. The two creeks meet about 5 km upstream of the outlet to Kalamalka Lake.
Comment: Report Title: King Edward Watershed Integrated Watershed Restoration Plan. Percentage works completed is: Uncertain

Activity Term: Start date: 01-MAR-98 End date:
Habitat(s): Upslope
Location(s): Watershed; King Edward Lake, tributary to the Coldstream Creek. Located just South of Vernon.

Project Name: Coldstream Creek Watershed Restoration
Description: Part of Forest Renewal British Columbia's Watershed Restoration Program, Coldstream Creek flows south from Silver Star Provincial Park onto a broad valley floor near Lavington, before discharging into Kalamalka Lake. The Coldstream Creek community watershed comprises that portion of the drainage area upstream of the Municipality of Coldstream water intake and treatment plant, and has a drainage area 6,643 ha.
Objective: The objectives of this project are to rehabilitate and restore the watershed from past disturbances such as logging, mining and road construction.
Project Status: Active **Start Date:** 01-APR-96
Lead Proponent: BC Ministry of Forests
Activity: Restoration - Overview Assessment
Description: The objectives of this activity were to: 1) define the potential negative cumulative or site-specific effects of past forest practices, and other land uses, on the watershed's hydrology, slope and channel geomorphology, and water quality and; 2) provide guidance on continued forest operations.
Comment: Report Title: Coldstream Creek: Watershed Assessment. Percentage works completed is: N/A
Activity Term: Start date: 01-DEC-98 End date:
Habitat(s): Riparian, Stream, Upslope
Location(s): Watershed; Coldstream Creek, tributary to the Vernon Creek. Located just South of Vernon.

Project Name: Okanagan Timber Supply Area (TSA) Small Lakes Inventory
Description: 1:20K reconnaissance lake inventory
Project Status: Active **Start Date:** 01-APR-98
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Inventory - 1:20000 Reconnaissance
Description: 1:20K Lake Reconnaissance Fish and Fish Habitat Inventory
Activity Term: Start date: 01-APR-98 End date:
Habitat(s): Lake
Location(s): Lake; Damer Lake, tributary to un-named creek, tributary to North Oyama/Oyama/Vernon Creeks/Okanagan/Columbia Rivers, near Vernon.

Project Name: Wood Lake Angler Survey / Creel Census
Description: Estimation of angler pressure/effort on the lake, estimation of number of kokanee and other species harvested, education of anglers towards kokanee conservation.
Project Status: Active **Start Date:** 11-MAR-00 **End Date:** 01-JUN-00
Lead Proponent: Oceola Fish and Game Club
Activity: Assessment - Stock Assessment
Description: Estimation of number of kokanee and other species harvested, estimation of angler pressure/effort on fish stocks.
Activity Term: Start date: 11-MAR-00 End date: 01-JUN-00
Target Species: Kokanee
Habitat(s): Lake

Location(s): Lake; Wood Lake, tributary to Vernon Creek, Okanagan Lake, Okanagan/Columbia Rivers, north of Kelowna.
Activity: Other - General
Description: Education: interviews were conducted with 90 percent of the anglers on the lake. Anglers learned of the purpose of the project and its rewards.
Activity Term: Start date: 11-MAR-00 End date: 01-JUN-00
Target Species: Kokanee
Habitat(s): Lake
Location(s): Lake; Wood Lake, tributary to Vernon Creek, Okanagan Lake, Okanagan/Columbia Rivers, north of Kelowna.

Project Name: Kelowna/McDougall/Vernon Creeks Urban Referral Compliance Evaluation
Description: Review of Water Act compliance and applications for 4 urban creeks.
Objective: Ensure that streams and riparian corridors in urban areas function properly and provide habitat for wild fish species.
Project Status: Active **Start Date:** 01-FEB-00 **End Date:** 31-MAR-00
Lead Proponent: Penticton Indian Band/Columbia Environmental Consulting
Activity: Inventory - Urban
Description: 4 urban creeks reviewed for the level of compliance to the Water Act for all approved and non approved works in and about the streams.
Activity Term: Start date: 01-FEB-99 End date: 31-MAR-00
Habitat(s): Riparian, Stream
Location(s): Main Stem of Stream; Vernon Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Vernon.
Activity: Inventory - Urban
Description: 4 urban creeks reviewed for the level of compliance to the Water Act for all approved and non approved works in and about the streams.
Activity Term: Start date: 01-FEB-99 End date: 31-MAR-00
Habitat(s): Riparian, Stream
Location(s): Main Stem of Stream; Vernon Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Vernon.

Project Name: Echo Lake Dam Restoration (86)
Description: Reconstruction of an earth-fill dam with an outlet flow control device and an overflow spillway to increase storage capability and increase the quality and quantity of rainbow trout production.
Objective: Increase the quality and quantity of rainbow trout production as part of the Habitat Conservation Trust Fund’s (HCTF) overall objective to appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-86
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Water Quality
Description: Reconstruction of an earth-fill dam with an outlet flow control device and an overflow spillway.
Activity Term: Start date: 01-APR-86 End date:
Target Species: Rainbow Trout
Habitat(s): Lake

Location(s): Lake; Echo Lake, tributary to Echo Creek, Swalwell Lake, Vernon Creek, Okanagan Lake, and Okanagan/Columbia Rivers, NE of Winfield.

Project Name: Vernon Creek Improvement Inventory
Description: A stream inventory conducted. Identification of the methods (e.g. channelization, culvert reconstruction, rip-rap and gravel placement), locations, timing and costs for stream improvements which would benefit kokanee.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-86
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Inventory - Other
Description: A stream inventory was conducted to identify the methods (e.g. channelization, culvert reconstruction, rip-rap and gravel placement), locations, timing and costs for stream improvements that would benefit kokanee.
Activity Term: Start date: 01-APR-86 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Vernon Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Vernon.

Project Name: Echo Lake Dam Restoration (87)
Description: Reconstruction of an earth-fill dam with an overflow spillway at the outlet to improve the quality and quantity of Rainbow trout production.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-87
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Water Quality
Description: Reconstruction of an earth-fill dam with an overflow spillway at the outlet.
Activity Term: Start date: 01-APR-87 End date:
Target Species: Rainbow Trout
Habitat(s): Lake
Location(s): Lake; Echo Lake, tributary to Echo Creek, Swalwell Lake, Vernon Creek, Okanagan Lake, Okanagan/Columbia Rivers, NE of Winfield.

Project Name: Vernon Creek Passage Improvement
Description: Improvement of passage for kokanee through construction of baffles within a culvert and weir, removing a concrete weir, and placing another weir to decrease water velocity. Volunteers coordinated to remove man-made debris.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-87
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Restoration - Restore Fish Passage
Description: Construction of baffles within a culvert and weir, removal of a concrete weir, placement of another weir to decrease water velocity, and removal of man-made debris.
Activity Term: Start date: 01-APR-87 End date:
Target Species: Kokanee

Habitat(s): Stream
Location(s): Main Stem of Stream; Vernon Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Vernon.

Project Name: Vernon Creek Habitat Improvement (88)
Description: Various stream enhancement activities for kokanee performed: boulder weirs placed, gravel spawning platforms constructed, stream clearance conducted, and 100 m of streambank excavated and stabilized.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Boulder weirs placed, gravel spawning platforms constructed, stream clearance conducted, and 100 m of streambank excavated and stabilized.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Vernon Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, runs through Vernon.

Project Name: Okanagan Drainage Warmwater Fish Enhancement (88)
Description: Enhancement of a Smallmouth bass fishery by controlling weeds, establishing riparian vegetation, transplanting bass, constructing refuge holes, and placing brush piles in lakes for rearing habitats.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-88
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Enhancement of a Smallmouth bass fishery by controlling weeds, establishing riparian vegetation, constructing refuge holes, and placing brush piles in lakes for rearing habitats.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Bass / Sunfish (General)
Habitat(s): Lake
Location(s): Point; 4 small lakes in the Okanagan region.
Activity: Enhancement - Fish Culture Activities
Description: Smallmouth bass transplanted into the lakes.
Activity Term: Start date: 01-APR-88 End date:
Target Species: Bass / Sunfish (General)
Habitat(s): Lake
Location(s): Point; 4 small lakes in the Okanagan region.

Project Name: Vernon Creek Habitat Improvement (89)
Description: Various stream enhancement activities preformed to enhance kokanee spawning habitat: stream clearance, gravel placement, and installation of a fish barrier at the creek junction.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.

Project Status: Active **Start Date:** 01-APR-89
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Stream clearance, gravel placement, and installation of a fish barrier at the creek junction.
Activity Term: Start date: 01-APR-89 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Vernon Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Vernon.

Project Name: Vernon Creek Habitat Improvement (90)
Description: Various stream enhancement activities performed to enhance kokanee spawning habitat: stream clearance, and gravel placement.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Active **Start Date:** 01-APR-90
Lead Proponent: BC Ministry of Environment Lands and Parks
Activity: Enhancement - Habitat Enhancement
Description: Stream clearance and gravel placement.
Activity Term: Start date: 01-APR-90 End date:
Target Species: Kokanee
Habitat(s): Stream
Location(s): Main Stem of Stream; Vernon Creek, tributary to Okanagan Lake, Okanagan/Columbia Rivers, near Vernon.

Project Name: Winfield Creek Enhancement
Description: Improve kokanee spawning habitat by excavating and replacing spawning substrate, excavating settling ponds to control silt and sand deposition, and re-aligning the stream course.
Objective: To appropriately conserve and, where necessary, enhance wild fish populations and their habitats.
Project Status: Completed **Start Date:** 01-APR-89
Lead Proponent: Oceola Fish and Game Club
Activity: Enhancement - Habitat Enhancement
Description: Improve Kokanee spawning habitat by excavating and replacing spawning substrate, excavating settling ponds to control silt and sand deposition, and realigning the stream course.
Activity Term: Start date: 01-APR-89 End date:
Target Species: Kokanee
Location(s): Main Stem + Tributaries; Winfield Creek tributary to Wood Lake, tributary to Vernon Creek, tributary to Okanagan Lake, tributary to Okanagan/Columbia Rivers.

Project Name: Coldstream Creek Renewal Project
Description: Land use mapping, hydrology assessment, design of water quality and streambed mapping, and research into previous work on Coldstream Creek
Project Status: Active **Start Date:** 07-FEB-99 **End Date:** 31-MAR-00
Lead Proponent: North Okanagan Naturalist Club
Activity: Inventory - Mapping
Description: Land use mapping within the watershed
Activity Term: Start date: 07-FEB-99 End date: 31-MAR-00

Habitat(s): Stream
Location(s): Main Stem + Tributaries; Coldstream Creek tributary to Kalamalka Lake/Vernon Creek/Okanagan/Columbia River near Winfield.
Activity: Assessment - Habitat Assessment
Description: Water quality and streambed monitoring
Activity Term: Start date: 07-FEB-00 End date: 31-MAR-00
Habitat(s): Stream
Location(s): Main Stem + Tributaries; Coldstream Creek, tributary to Kalamalka Lake/Vernon Creek/Okanagan Lake/Okanagan/Columbia Rivers.

Watershed Assessment

To ensure that streams and riparian corridors within urbanized areas are functioning properly in order to provide habitat for wild fish species, a review of Water Act Compliance (B.C. provincial govt., 2000) can be conducted. The Urban Referral Compliance Evaluation is a Fisheries Renewal BC initiative. Fisheries Renewal BC is a provincial Crown corporation created to revitalize the province's fish resource and the communities that depend on it. The proponents will record the level of compliance for approved and non-approved works in and about urban streams. This evaluation will enable resource users to determine the need for further compliance evaluations and help develop restoration objectives within the urban environment. Several tributaries to the Okanagan basin located within urban areas have undergone such a review; these include Kelowna (Mill), McDougall, and Vernon creeks.

Reconnaissance Fish and Fish Habitat Inventories, at the 1:20,000 scale, have been conducted for the Naramata, Trepanier, Chute, Trout, and Shingle watersheds. These inventories are intended to determine fish presence or absence, species type, potential barriers to fish, and the overall state of the watershed. Participants in this type of inventory range from forestry companies to First Nations groups to government agencies. These studies have been mainly conducted through the provincial “Forest Renewal BC Program”, and are predominantly for subwatersheds that are slated for forest harvest activities.

Several watershed assessments and sediment source surveys have been conducted in the Okanagan Watershed, and to a lesser extent in the Similkameen watershed. These studies have been mainly conducted through the provincial “Watershed Restoration Program”, and are predominantly for subwatersheds that have previously experienced forest harvest activities. Several significant tributaries to the Okanagan Basin have been assessed. In the Similkameen Basin, there have been some watershed assessments done, some road condition assessments conducted, and similarly some sediment source and habitat assessments performed; however, it has generally been cursory in nature and only a few of the subwatersheds have been assessed. For example, the Ashnola River subwatershed has had a sediment source and channel assessment conducted. Several subwatersheds downstream of Princeton have had work done, while upstream of Princeton little has been done in the way of watershed assessments.

In addition, fish population estimates can be estimated using a creel census. The Oceola Fish and Game Club conducted such a census on Wood Lake, with the purpose of estimating the angler pressure and effort on the lake and to educate anglers regarding kokanee conservation strategies and benefits.

Limiting Factors

Kokanee is a key management focus within the Okanagan Basin. Currently the number of kokanee present in Okanagan Lake represents 10 percent of historical numbers supported by this system. As noted earlier, the decline in kokanee stocks culminated in the 1995 closure of the kokanee sport fishery. This decline also led to the formation of the Okanagan Lake Action Plan, the focus of which was to define limiting factors to kokanee production, and to identify and implement remedial measures.

An Adaptive Environmental Assessment was conducted on Okanagan Lake to determine factors affecting kokanee production. The most obvious problems limiting production included the deterioration of spawning and rearing habitat for stream spawning kokanee in tributaries to the Okanagan system. Human impacts such as flood control measures and demands for water for irrigation have resulted in channelization of some tributaries while others are completely devoid of water during the spawning season. Another key finding was that both shore and stream spawning kokanee populations had declined due to reductions in lake nutrients and due to competition from the introduced mysis shrimp for food. Loss of both stream and shore spawning habitat accounts for 90 percent of the reduction in kokanee stocks, while a low in-lake survival rate due to an offset nitrogen to phosphorous ratio and the presence of mysis shrimp is accountable for the other 10 percent. In other words, Okanagan Lake no longer has the carrying capacity to support historical levels of kokanee.

Artificial Production

Extensive fish stocking has occurred throughout both the Okanagan and Similkameen watersheds for several years. The species of fish stocked in these areas include rainbow trout, kokanee, and brook trout from a variety of stocks and at different life cycle stages. Fish stocking has occurred not only in the Okanagan and Similkameen mainstems, but in other major tributaries to these rivers including Kelowna (Mill), Mission, Peachland, Penticton, Trepanier, and Vernon creeks. Records do not indicate any stocking activities in Powers Creek. Other major tributaries in these watersheds have also been stocked.

Artificial production facilities within the Okanagan Watershed that have stocked these tributaries in the past include Skaha and Summerland hatcheries. Fraser Valley Hatchery (in the Vancouver lower mainland region) has stocked rainbow trout in the Similkameen Watershed.

Existing and Past Efforts

Summary of Past Efforts

Several provincial and federal programs are in place which are starting to rectify disturbances within the Okanagan Watershed, and which are aimed at accelerating natural recovery of disturbed watersheds. These include programs such as “Forest Renewal BC” and “Fisheries Renewal BC”. However, these programs are currently unable to address all of the past, present, and anticipated pressures on fish, wildlife, and habitat that exist within the Okanagan Watershed.

Sediment Source Surveys

Identification of the source of sedimentation is the first step to eradicating the problem. As noted above, some sediment source surveys have been conducted under the Watershed Restoration Program. Unfortunately, many subwatersheds have not yet undergone such surveys. Moreover, it appears that remedial prescriptions exist for only a few watersheds.

Sedimentation of spawning habitat results in eggs not getting enough oxygen and suffocating. The end result is reduced production. Erosion control (rectifying the problem at the source) can be effective using a variety of techniques. In Peachland Creek the Ministry of Environment, Lands, and Parks (MELP) constructed a series of check dams to minimize siltation in the creek and to stabilize the entire gully which is used by kokanee. The University of British Columbia tested and evaluated gravel cleaning equipment which remove the fine sediments from spawning substrates through hydraulic agitation and suction discharge. The equipment could potentially be used to clean spawning habitat and make it suitable for productive kokanee spawning.

Watershed Restoration

Watershed restoration encompasses a variety of activities with a common goal to rehabilitate a watershed to pre-impact conditions. The Forest Practices Code delineates guidelines for conducting watershed assessments in order to determine the extent of the damage and to identify potential priority sites for remediation. Several watershed restoration programs have been conducted throughout the Okanagan and Similkameen basins by a variety of proponents, including forestry companies, government agencies, and First Nations groups. Kelowna (Mill) Creek, Mission Creek, Peachland Creek, Trepanier Creek, and Vernon Creek have all been included in a watershed restoration program. In the Similkameen Basin, Ashnola River, Hedley Creek, McNulty Creek, Cahill Creek, Winters Creek, Willis Creek, Tulameen River, Old Arrastra Creek, and Oyama Creek are among the tributaries to have had watershed restoration evaluations conducted.

Stream Restoration

A watershed restoration project on Kelowna (Mill) Creek conducted by the city of Kelowna resulted in streambank stabilization for 450 meters and 1,400 meters of riparian planting. Instream efforts included 450 meters of instream complexing. The project also included open houses and published articles that increased public awareness for the importance and benefits of stream restoration projects.

Following a flood control project, the Ministry of Environment, Lands, and Parks set out to plan and identify potential spawning habitat enhancement projects with input from the public.

Tolko Industries Limited undertook a watershed restoration project on the Tulameen River in order to protect, restore, and rehabilitate fisheries and aquatic and forest resources that had been adversely impacted by past disturbances such as logging, mining, and construction within the watershed. The Tulameen River drains to the Similkameen River just north of Coalmont. The watershed is 1,780 square kilometers in size.

The First Nations of Okanagan-Similkameen Environmental Protection Society conducted a watershed restoration project in the Arrastra Creek Watershed. The area involved encompasses an area of 150 square kilometers, all of which eventually drains to the Similkameen River via the Tulameen River. The watershed has been modified through timber harvesting and livestock free ranging activities as well as recreation. The objectives of the project included protection, restoration, and rehabilitation of the natural resources that have been adversely impacted in the watershed.

Ardew Wood Products Ltd. conducted a restoration program in the Granite Creek Watershed which drains to the Tulameen River.

Habitat Restoration

Habitat degradation due to human influences such as agriculture, urban development, and forestry have negatively impacted the Okanagan and Similkameen watersheds. The streams and lakes within these basins no longer have the carrying capacity to support the historical numbers of species once found in these waters. Efforts are being made to restore habitat to suitable spawning grounds in order to increase this carrying capacity and thus increase populations.

The Mission Creek spawning channel is a prime example of efforts put forth to increase suitable habitat, particularly for stream-spawning kokanee. Several groups have been and continue to be involved with Mission Creek in order to increase kokanee productivity in the Okanagan basin. Of the 66 kilometers of suitable spawning habitat available and accessible to kokanee in this watershed, 19 kilometers are found in Mission Creek. Major improvements were made to the spawning channel in 1988 namely improvements and realignments to the intake structures of the 1,000-meter long channel, gravel placement below high-water mark for spawning purposes, and regrading of the channel. In the early 1990s, evaluations of the spawning channel were conducted by MELP for a variety of purposes namely estimates of kokanee egg-to-fry survival rates and enumerate fry and adult kokanee use of the spawning channel. In conjunction with the Habitat Conservation Trust Fund, MELP undertook moving beach gravel to below the high water mark to create additional kokanee spawning habitat. In 2000, the Okanogan University College completed a plan for water management and fish enhancement goals for the lower 8 kilometers of Mission Creek to increase spawning habitat capacity.

Efforts on the Okanagan River to increase kokanee spawning habitat include replacement of gravel on 400 meters of the river.

Spawning enhancement activities on Peachland Creek include the construction of 300 square meters of gravel platforms upstream from previous enhancement activities and the monitoring of these gravel platforms over the years to assess effectiveness. MELP’s plans include siltation control measures, rock weir construction and repair, and incubation boxes to improving kokanee production in Peachland Creek.

The Penticton Flyfishers group made improvements to an existing fish ladder on Penticton Creek in 2000. The objective was to allow fish access to an additional 600 meters of stream that encompassed potential spawning habitat in an effort to increase kokanee production in Penticton Creek and the Okanagan Basin.

Powers Creek experiences low flows which can strand kokanee eggs. MELP collected information and developed a plan for sharing water storage in Tadpole Lake with Westbank Irrigation District in order to secure minimum flows for Powers Creek.

Various stream enhancement activities to improve kokanee production in Vernon Creek have been conducted by MELP. Boulder weirs have been placed in the creek to provide cover for fish, gravel spawning platforms have been constructed, and 100 meters of streambank were stabilized to reduce sedimentation. Maintenance of spawning platforms such as gravel placement has increased spawning habitat for kokanee in Vernon Creek.

Perhaps the most progressive method for mitigating the declining kokanee stocks due to the introduction of the mysis shrimp to Okanagan Lake is the Mysis Beam Trawl Harvesting Feasibility Study. In-lake population estimates for mysis shrimp were conducted in order to develop an efficient harvesting technique. Marketing studies were also performed to determine harvest product acceptability within the marketplace, and a harvest technique costs and benefits analysis was done to ensure financial feasibility. Several methods were brought to the Okanagan Lake Action Plan committee members and a variety of harvest techniques were attempted based on the biology and ecology of the mysis shrimp. An estimate suggests that a 10 percent capture would have an effect on the overall population of mysis shrimp. The market research and the cost and benefit analysis both resulted in favorable responses and the technique is now being considered for use in other lakes where the mysis shrimp was introduced.

Barrier Identification and/or Removal

Barrier identification and removal could potentially allow fish access into suitable spawning habitat within a watershed. An inventory was conducted in the Okanagan region to identify non-natural potential barriers to fish passage. The Okanagan Region Wildlife Heritage Fund Society conducted the inventory from 1999 to 2000 and identified 186 potential fish passage obstructions.

Work was conducted on Powers Creek to allow fish access to spawning habitat upstream of barriers. In 1986, a fishway was built to assist kokanee in bypassing a rock obstruction. The proponent of the project was the MELP and was part of the Habitat Conservation Trust Fund’s (HCTF) overall objective to conserve and enhance wild fish populations and their habitats. Also on Powers Creek, an identified hazard to migrating rainbow trout fry was rectified. The existing unscreened diversion from the creek was replaced with a screened diversion to prevent rainbow trout from becoming trapped in the irrigation canal. This project was also conducted by MELP and HCTF in an effort to fulfill their respective mandates.

A preliminary evaluation of a proposed spawning channel was conducted by the Trepanier Creek Linear Park Society in 1999. The development of the spawning channel was developed to address fish habitat issues in the creek, namely low flows, sedimentation from the Macdonald Creek landslide, and existing municipal issues. The evaluation led to stewardship and community involvement by promoting fish spawning habitat enhancement.

Construction of an earth-filled dam with an overflow spillway was undertaken by MELP in 1989. The objective of the project was to increase rainbow trout production and to provide access for adult trout into Rampart Lake as part of the Ministry's mandate.

Education/Public Awareness

Public awareness and involvement in all aspects of restoration and rehabilitation programs is key to the initiation and continued success of these projects. Several attempts have been made within the Okanagan and Similkameen watersheds to inform the public of upcoming and ongoing projects to enhance these areas. Typically in the form of open houses and public forums, other effective methods for passing information to the public include interpretive signage, the Okanagan storm drain marking program, education programs for local schools, volunteer and interest groups, and guided tours of successful enhancement projects.

Interpretive signage has been installed on Kelowna (Mill) and Penticton creeks, for example. These signs convey information about Okanagan Lake kokanee and habitat issues within this watershed. A Mission Creek awareness program assembled by MELP included a 12-panel information kiosk and an accompanying brochure to promote fisheries awareness. Another effort to increase public awareness of the importance of Okanagan Lake fisheries was produced by the Habitat Conservation Trust Fund in the form of a video, information pamphlet, and slide show presentation.

Coordination of school classroom incubation and bank stabilization programs as well as interpretive field trips to the Mission Creek spawning channel educate students on the importance of environmental stewardship and rehabilitation.

Guided educational tours of Peachland Creek explained kokanee spawning ecology to school groups and the general public.

Present Subbasin Management

Existing Management

Federal and provincial agencies, local municipalities, tribal groups, and public interest groups all manage, regulate, or otherwise are involved in land and water usage within their respective jurisdictions. For the most part, these governing bodies and stakeholders have policies and guidelines to control the demands placed upon the watershed and their mandates include the management of natural resources for society while maintaining a level of protection of water, land, fish, and wildlife resources. Several of these organizations and their mandates are described below.

BC Ministry of Fisheries (MoFs)

BC Fisheries is a provincial government agency that is responsible for the management of freshwater recreational fisheries, aquaculture activities, and marine plant harvesting, and regulating the sale, inspection, and processing of fish. The province also exercises delegated authority under the federal Fisheries Act for the management of the non-salmon freshwater fisheries and wild oyster harvest.

BC Hydro

BC Hydro is the main hydropower generator in BC, and is a crown corporation (owned by government, but operated as a semi-autonomous corporation. BC Hydro's stated goal is "to provide energy solutions to our customers in an environmentally and socially responsible way".

BC Ministry of the Environment, Lands and Parks (MELP)

BC MELP is a provincial government agency whose stated mandate is to protect and conserve natural resources, maintain and restore the quality of land, water, and air, and manage water resources for the optimum health of humans and all living things, now and for future generations. The ministry supports human social, recreation, and settlement needs, environmentally sensitive economic development, and the sustainable use of resources, and seeks to ensure the government receives a fair return for the use of public resources.

BC Ministry of Forests (MoF)

BC MoF is a provincial government agency that strives to encourage maximum timber resource productivity. Its mandate is to manage timber resources responsibly to achieve the greatest short- and long-term social benefits; practice integrated resource management; encourage a globally competitive forest industry; and assert the financial interests of the Crown.

Canada – BC Agreement on the Management of Pacific Salmon Fishery Issues

The Pacific Fisheries Resource Council advises the Council of Fisheries Ministers regarding matters of conservation and long term sustainable use of salmon resources and habitat. Both governments agreed to establish a joint Fisheries Renewal Advisory Board, including stakeholder and community representation, to coordinate each government's respective development and delivery of programs in the areas of habitat restoration and salmonid enhancement. The Board has a mandate to directly involve stakeholders and communities in setting priorities for restoration and enhancement and in program delivery.

Coho Recovery Plan

Protecting and rebuilding coho stocks is the key focus of this plan. The major components of the plan are habitat protection and restoration, strategic stock enhancement, stock assessment, enforcement and catch monitoring, and public education. It is unclear whether coho may potentially reach the Canadian portion of the Okanagan Watershed, and thus it is unclear if this recovery plan may potentially apply to the Okanagan Watershed.

Columbia Basin Trust

The Columbia Basin Trust manages assets, including money allocated by the Province for power projects and other investments, for the ongoing economic, environmental, and social benefit of the region, without relieving governments of their obligations. This money comes from a transfer of funds that are provided to the provincial government as part of the "downstream benefits" aspect of the Canada-U.S. Columbia Basin agreement. By investing money in local businesses (including hydroelectric operations) and occasionally in other cultural, educational, or ecological activities, the Trust promotes development of power projects while maintaining environmental integrity.

Columbia Basin Fish and Wildlife Compensation Program (Canada)

This program is jointly managed by BC Hydro and BC Ministry of Environment, Lands, and Park. Its purpose is to conserve and enhance fish and wildlife populations affected by BC Hydro dams in the Columbia Basin. The program's primary mandate is to protect and rehabilitate fish, wildlife and their habitats. The program conducts project and funds many other projects by other organizations (which they refer to as "partners"). First Nations groups are one of their target partners. This program does not include the Okanagan Basin, but may have some technical expertise of benefit to the current Okanagan Watershed program objectives.

Environment Canada

Environment Canada is a federal agency whose mandate is to preserve and enhance the quality of the natural environment, including water, air, and soil quality. In addition, this agency strives to conserve Canada's renewable resources, including migratory birds and other non-domestic flora and fauna, and to protect Canada's water resources. Environment Canada enforces the rules made by the Canada–United States International Joint Commission relating to boundary waters, and coordinates environmental policies and programs for the federal government. Environment Canada holds authority under the federal Fisheries Act for the management of deleterious substances in aquatic systems.

Fisheries and Oceans Canada (FOC)

Fisheries and Oceans Canada is responsible for policies and programs in support of Canada's economic, ecological, and scientific interests in oceans and inland waters. Its mandate includes the conservation and sustainable utilization of Canada's fisheries resources in marine and inland waters; leading and facilitating federal policies and program on oceans; and safe, effective, and environmentally sound marine services responsive to the needs of Canadians in a global economy. FOC is the main agency holding authority under the federal Fisheries Act for the management of fish and fish habitat.

Fisheries Renewal BC

Fisheries Renewal BC is responsible for a wide range of initiatives including promoting the protection, conservation, and enhancement of fish stocks and habitat. This program was also designed to create jobs in the fisheries sector and to facilitate planning and fisheries-related investments in partnerships with different sectors of BC fisheries and with BC communities. Developing local infrastructure that will encourage fisheries-related employment and investment in communities and building a multi-skilled workforce in fishing communities is another of this agency's mandates. These goals are achieved by supporting employment, training, and technological development and by providing assistance and advice to government on how best to coordinate and deliver fisheries-related programs. Top priorities will be programs for fisheries restoration and enhancement, commercial and recreational fisheries diversification and development, skills training for fisheries workers, community-based fisheries job creation strategies, and development of long-term provincial fisheries renewal strategy.

Forest Renewal BC

Forest Renewal BC develops and implements plans including investments to renew the forest economy of British Columbia by enhancing the productive capacity and environmental values of forest lands, and by creating jobs, providing training for forest workers, and strengthening local communities that depend on the forest industry. This agency conducts operational inventories (including fish and fish habitat assessments), watershed restoration program (WRP) (including identification of impacts and opportunities for improvement), as well as actual restoration projects.

Habitat Conservation Trust Fund

The Habitat Conservation Trust Fund was set up to pursue habitat preservation, restoration, and enhancement, species conservation, land stewardship, environmental education, and land acquisition. The fund has an approximate budget of $5 million Canadian per year that is generated from hunting and fishes license surcharges.

Habitat Restoration and Salmon Enhancement Fund (HRSEP)

The purpose of this fund is to pursue habitat restoration, salmon stock rebuilding, and resource and watershed stewardship.

Kokanee Salmon Heritage Project (Okanagan)

The Kokanee Salmon Heritage Project was developed as a result of the myriad of questions about kokanee which arose during school and public interpretative talks at the Mission Creek Spawning Channel in Kelowna, BC. The scientific authority for the project is Dr. Peter Dill, a researcher on trout and salmon in Canada for some 30 years and on okanee in the Okanagan for the past ten years. Dr. Dill is a biology professor at Okanagan University College.

Okanagan Basin Technical Working Group

This group is a cooperative endeavor between Okanagon Nations Alliance (ONA), FOC, and MoFs/MELP to identify and design mitigation measures for impacted sites within the Okanagan Basin. Current activities include restoration works in the Skaha Lake system that is funded by the Douglas County Public Utilities District.

Okanagan Nations Alliance (ONA)

The Okanagan Nations Alliance has an inherent right and responsibility to enjoy, manage and protect its peoples, lands, resources and forms of government as stated in the *Okanogan Nation Declaration* of August 22, 1987. Their mandate is to strive for the advancement, assertion, support, and preservation of the Aboriginal Rights of the Okanogan Nation. The ONA promotes protection, enhancement, and preservation of the peoples, lands and resources, including fish and wildlife, of the member bands.

Provincial Okanagan Lake Action Plan

The Okanagan Lake Action Plan took shape in 1996 after the closure of the kokanee sport fishery the previous year. The goal of the plan is to identify biological relationships within Okanagan Lake to determine limiting factors to kokanee production. In addition, the plan will determine remedial measures that will result in the recovery of the lake's kokanee population.

Provincial Water Use Planning (WUP)

All water management groups (including BC Hydro) are assessing how to better balance the social, economic, environmental, and recreational and power generation uses of water. WUP will define the operating parameters to be applied in the day-to-day operations of the facilities in order to meet these goals.

Restructuring Canada's Pacific Fishery

This program is a predominantly federal initiative to protect and restore Pacific fisheries. It includes fisheries and license restructuring, community economic development in an attempt to rebuild the fishery resource within the province.

Rebuilding the Resource

This program is a predominantly federal initiative to assist in the protection and restoration of Pacific fisheries. It includes HRSEP and community stewardship groups to develop strategic enhancement of specific stocks of concern.

Salmonid Enhancement Program

This program is a predominantly federal initiative to protect and restore salmonid populations and habitat. The Salmonid Enhancement Program is mainly involved in incubation and rearing programs (including the operation of fish hatcheries). Some habitat improvement activities are conducted by the group as well.

South Okanagan Similkameen Conservation Program (SOSCP)

Run by the Federal Ministry of the Environment, the South Okanagan-Similkameen Conservation Program consists of a large fund that is mainly used for the purchase of land.

Transborder Pacific Salmon Southern Boundary Restoration and Enhancement Endowment Fund

The fund was established under the "Pacific Salmon Agreement" between Canada and the U.S. to sponsor habitat rehabilitation and fishery enhancement projects in both countries. The fund will also fund studies to improve the scientific understanding of factors affecting salmon production in freshwater and marine environments.

Wild Salmon Policy

This program is a predominantly federal initiative to assist in the protection and restoration of Pacific fisheries. The goal of the Wild Salmon Policy is to conserve the long-term viability of Pacific salmon populations and their natural habitats by focusing on the genetic diversity of populations and habitats.

Subbasin Recommendations

Subbasin recommendations – subbasin teams project review

Projects and budgets

- Projects funded by Bonneville proposed for continuation for the next 3 years including an explanation of their relationship to the assessment information, other existing activities, and management goals, objectives and strategies.
- Identify new and existing research, monitoring, and evaluation activities.
- Needed for future actions – additional future efforts needed to achieve objectives to be funded by Bonneville.
- Actions by others – additional efforts needed to achieve objectives to be funded by others.

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RE: Okanogan County Comments on "Draft Okanogan/Similkameen Subbasin Summary; 11 May 2001"

Dear Mr. Wolf and Mr. Peone:

The following are Okanogan County's comments on the Draft Okanogan/Similkameen Subbasin Summary; 11 May 2001.

First, we would like to comment on the tone and conclusions made in the document. It is our understanding that this is a technical document and therefore conclusions drawn within the document need substantial scientific support. In many sections of the document conclusions are drawn without specific scientific information. For example on Page 76, section titled "Exotic Species" it reads: There are numerous introduced species in the basin. Many of these were introduced as game animals. The practice of stocking exotic wildlife for hunting ended in 1983 (OWSAC. 2000). Declines in pheasant and chukar populations since then are a result of this policy change as well as changes in habitat and weather conditions. Table 23 is a listing of the species introduced into the Okanogan River watershed." In examining the Chukar and Ring-necked pheasant data in Table 23 it is listed as "Unknown" when the species were introduced or their current status. We question if adequate science has been collected to make the determination that these species are on the decline. Realize that we make this comment because the information presented in the document does not support the conclusion stated. Other determinations have been made through out the document without supportive scientific information.

Secondly, most of the negative attributes in the Okanogan Basin are accredited towards livestock and logging. For example on Page 25, First paragraph of the page it reads: "Livestock grazing practices have led to trampled streambanks, and increased bank erosion and sedimentation, changes in vegetation – including loss of native grasses impacts to woody vegetation, and noxious weeds." We believe this to be a one sided conclusion. We acknowledge that livestock and logging can impact stream banks, habitat, and vegetation but to what degree and is it all negative? More unbiased scientific information needs to be collected before these types of conclusions can be supported. Furthermore, there is no mention in the document about the impacts that recreation or non-domestic animals have on the attributes of the Basin. By not considering all of the possible contributors towards negative impacts on the Basin's attributes, this does not provide a balanced, unbiased technical review of the Basin.

Thirdly, on page 160, the document lists "Statement of Fish and Wildlife Need", "Floodplain and Riparian Needs", Uplands and Forest Needs", and finally, "Subbasin Recommendation". There is not enough language in the bullets following the titles to affirm or disaffirm whether or not we agree with the list. Many of the items on the list will effect the economic base of Okanogan County. As representatives of the constituents who rely on the economic base and financial stability of Okanogan County to survive, we must know all of the components of these proposed projects and recommendations before we can make accurate comments. In addition, perhaps a title needs to be added such as "Needs of People". Under this title items that need to be addressed are "Examine water storage possibilities, above and below ground, to supplement instream flows and irrigation needs." and "Power generation opportunities." Even if another title is not added, these items need to be addressed in the document. No matter what actions are taken, the impacts on people need to be considered. This document solely focuses on the needs of fish and native wildlife and we believe that the needs of people must be considered as well otherwise it relays the concept of fish before people.

And lastly, since public funds are being used to fund this process, why is there not a public comment period? Reviewing the list of people that have contributed to the document there are not any from the general public. This subbasin summary and subsequent projects completed from this summary is going to have an impact on the citizens of the County. The citizens of the County should have an opportunity to comment on those things that are going to effect them.

We realize that the intent of the comment period is to highlight specific suggestions and provide alternatives. We believe that if we make specific suggestions to change items in the document that it will mean that we would agree with the other items in the document when this would not be so. We intend for this letter to be included in the final Okanogan/Similkameen Subbasin Summary.

If you have any questions or need further information, please do not hesitate to contact any of the Okanogan County Board of Commissioners.

Sincerely,

Robert Hirst, Chairman
Okanogan County Board of Commissioners