COLUMBIA GORGE MAINSTEM SUBBASIN PLAN

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Lead Planning Entity:

Oregon Department of Fish and Wildlife

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1 Executive Summary

The Columbia Gorge Subbasin Plan concerns the mainstem Columbia River between Bonneville and The Dalles dams in western Oregon and Washington. Tributaries to this reach, Bonneville Reservoir, are included in other subbasin plans, thus are not included here. The Oregon Department of Fish and Wildlife (ODFW) is the designated lead entity for developing the plan. ODFW is a co-manager of the fish and wildlife resources of the subbasin. ODFW's mission is to protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations. The planning process involved a number of federal, tribal, state, and local agencies, as well as regional organizations.

1.1 Assessment

1.1.1 Subbasin Overview

Bonneville Reservoir includes the present wetted channel from the forebay of Bonneville Lock and Dam upstream through the tailrace of The Dalles Dam. It includes the embayments, backwaters, and mouths or lower reaches of tributaries and associated seasonally flooded and riparian lands. Bonneville Dam impounded the Columbia River at river mile 145 in 1938. The Dalles Dam was built in 1957 at river mile 191. Bonneville Reservoir is entirely within the Columbia River Gorge National Scenic Area.

The drainage area of the subbasin and its tributaries is about 3,300 square miles, approximately 1.4 percent of the entire Columbia River Basin upstream of Bonneville Dam. The volume of the reservoir is 537 kaf and average. Tributaries of the subbasin contribute approximately 3.9% of the discharge through the subbasin.

Landscape surrounding Bonneville Reservoir is characterized by steep forested hillsides underlain by basalt up to 1,524 m thick with sedimentary and recent alluvium deposits. Elevations range from about 53 m below mean sea level (the deepest river bed elevation in Bonneville Reservoir) to over 1,150 m on mountains bordering the river just west of Hood River, Oregon. The valley floor is naturally and artificially constrained to various extents throughout the subbasin depending on the slope at and above the shores.

The combined effect of climate, soils, and geology on terrestrial habitat types is manifest in the types of plant communities present along the edges of the subbasin and on its islands. Historically, the western third of the subbasin was forested with conifers and hardwoods with smaller areas of riparian wetlands. The approximate middle third of the subbasin transitioned from coniferous forest with ponderosa pines to dominant ponderosa pine forest. The eastern-most third of the subbasin changed to grasslands and then to shrub steppe habitat to the east.

Modern land uses within the subbasin include residential, commercial, and industrial development in urban centers including Stevenson, Home Valley, and Bingen, Washington and

Cascade Locks, Hood River, and The Dalles in Oregon. The three Oregon urban centers contain marine industrial sites of varying sizes consisting of maintained harbors, reclaimed building sites, and shoreline moorings. Highway S.R. 14 parallels the north shore throughout the subbasin and Interstate Highway 84 runs along the south shore. The Burlington Northern Railroad runs parallel to the north shore and the Union Pacific Railroad runs along the south shore. These transportation corridors are reinforced by riprap revetments along significant lengths of shoreline. Hydraulic connection beneath portions of the transportation corridor between embayments (and mouths of streams) and the river's mainstem is accomplished through culverts, bridges, and trestles. Agriculture is prominent along the middle and eastern portions of the subbasin, particularly on the southern side of the river. State and federal land ownership along the shoreline throughout the subbasin (including islands) is extensive.

Bonneville Reservoir was developed and is operated by the U.S. Army Corps of Engineers for hydropower generation and navigation. Other river uses include recreation (e.g., angling, windsurfing, kite skiing, boating, water skiing, sightseeing, bird watching, swimming, and waterfowl hunting) and tribal commercial, ceremonial, and subsistence fishing.

Islands are a significant component of Bonneville Reservoir particularly for birds and other wildlife. They provide important protection to many species from disturbance and predation, provide nesting habitat for a number of bird species, and could represent a potential dispersal route between reservoir shores. Islands are distributed throughout the reservoir.

The largest island in the reservoir is Wells Island, downstream from the mouth of Hood River. Prior to construction of Bonneville Dam, it was connected with the mainland and had a land area over twice as large as the 50 acres that remain uninnundated. Portions of its shoreline are actively eroding, threatening existing wildlife habitat. The island is the site of the only blue heron rookery in Bonneville Reservoir (the rookery has not been inhabited in recent years). It has some of the last remaining hardwood habitat of its type in the reservoir, and has potential to fill nesting requirements of important bird species like the bald eagle (personal communication, C. Flick, USFS, Hood River). Invasive plants including Himalayan blackberries, scotch broom, and thistle has begun to encroach. The island is owned and managed by USFS.

1.1.2 Fish Species Characterization and Status

A diverse community of fishes exists during at least some life stage in the subbasin. Thirtyseven species in 13 families have been observed. Of these, 17 species in six families are exotic or non-native. The eulachon and chum salmon have been extirpated from the subbasin since development of the federal Columbia River power system. Most of the species observed remain in the subbasin throughout their life naturally or because they are largely constrained within the barriers presented by Bonneville and The Dalles dams (e.g., white sturgeon). Anadromous fish that primarily use the subbasin as a migration corridor (upstream as adults and downstream as juveniles) include stream-type Chinook and sockeye salmon. Species that may use the subbasin for significant portions of their life history include Pacific lamprey, American shad, bull trout, ocean-type Chinook salmon, coho salmon, and rainbow trout (steelhead).

1.1.3 Selection of Focal Fish Species

White sturgeon fisheries are intensively managed, and the majority of harvest upstream of Bonneville Dam occurs in Bonneville Reservoir. The animal uses the benthic environment extensively, is long-lived, and matures at comparatively older ages. Its diet is unique compared to other fishes and includes benthic invertebrates, some of which are long-lived bio accumlators (e.g. alien and native mussels). The sturgeon is assumed to be an important indicator of sediment quality. They are largely confined within the reservoir and subject to the environmental conditions unique to that reservoir. The fish is significant to tribal culture. Availability of stock assessment information is considerable.

Chum salmon are listed under federal ESA, historically entered the planning area, and are genetically similar to chum salmon in the Bonneville Dam tailrace. Their historic range may contribute importantly to the species' spatial structure and diversity. They spawn in low gradient streams or seeps that may have been inundated or affected by reservoir operations. Juveniles have a different vulnerabililty to environmental stressors than other salmonid species, because of their relative small size at outmigration.

Pacific lamprey are a state species of concern and have been petitioned to be listed under the federal ESA. They have unique adult upstream passage requirements and a prolonged juvenile rearing period in fine substrates. The portion of their life history spent within Bonneville Reservoir is uncertain, but adults are known to stage for a prolonged period, and larvae and ammocoetes have been known to occur in large mainstem river systems. Both adults and juveniles are prey for mammals, birds, and fish. They are significant to tribal culture.

1.1.4 Wildlife Species Characterization and Status

Because information on population dynamics is often lacking or less detailed for non-game wildlife compared to fish species, this assessment is less detailed. This assessment attempts to use the NPPC-sponsored Interactive Biodiversity Information System (IBIS) to characterize wildlife habitat types and long term changes at a broad scale. Also, because the numbers of species are large, the scope of the assessment is narrowed by identifying focal species that rely on habitats that are unique to Bonneville Reservoir, and depend on both aquatic and terrestrial habitats. Inventorying habitat structure or quantifying "key ecological functions" is beyond the scope of this draft subbasin plan. However, these principals are discussed briefly using Wells Island as an example.

1.1.5 Selection of Focal Wildlife Species

Bald eagles nest, forage, and overwinter in the Columbia Gorge Ecoprovince. They are listed under state and federal ESAs and are of national cultural significance. They have a direct link to aquatic resources (e.g., they prey on fish and waterfowl). They have an important ecological role by contributing marine nutrients to uplands. They can be an important indicator of forest structure (availability of large trees for nest sites and roosts) and water quality (they are relatively long-lived and susceptible to contaminants accumulated in their prey).

The western pond turtle is declining throughout most of its range, is highly vulnerable to extirpation in Oregon and Washington, and has been extirpated from most of its range already. As a result, the western pond turtle has been listed as endangered by the state of Washington.

Three populations remain in the Columbia River Gorge, two in Washington and one in Oregon. The total number of western pond turtles in known Washington populations is estimated at only 250-350 individuals, many of which went through the head-start program at the Woodland Park and Oregon zoos. Additional turtles may still occur in wetlands that have not been surveyed. The species requires a continued recovery program to ensure its survival until sources of excessive mortality can be reduced or eliminated.

1.1.6 Limiting Factors and Conditions

White Sturgeon

Recruitment to the population is thought to be the key factor controlling the abundance and population structure of white sturgeon. Therefore, we list recruitment to the egg/larval stages as a primary limiting factor for all life stages. Impacts of predation on white sturgeon at various life stages are poorly understood, as are ecological interactions between sturgeon of various life stages and other species, making it difficult to identify limiting factors in these areas. Connectivity and passage issues are likely limiting factors for nearly all life stages of white sturgeon. The impacts of contaminants on white sturgeon populations are relatively poorly understood. Negative impacts may include reduced spawning success and reduced growth, as well as direct or delayed mortality. Harvest by sport and commercial fisheries are limiting factors for all life stages to the extent that they impact the available abundance of spawning size fish, which produce subsequent generations.

Chum Salmon

Factors that limit production of chum salmon in the Columbia River Gorge are not explicitly known. Assuming that historical populations of chum salmon upstream of Bonneville Dam experienced the same stressors in the lower river, estuary, and ocean, as the populations downstream of Bonneville Dam, factors that could limit chum salmon production in the Columbia River Gorge include:

- Loss of habitat through inundation by Bonneville Dam.
- Lower propensity to ascend the fishways at Bonneville Dam compared to other anadromous species.
- Blockage to tributary habitats created by the transportation corridors or hatchery weirs.
- Sedimentation of spawning and rearing habitats in tributaries and nearshore areas of the mainstem.
- Intermittent dewatering of spawning gravels caused by operation of the FCRPS.
- Land use development along low gradient streams.

- Decreased rate of recruitment of large woody debris to lower reaches of tributaries and nearshore areas of the mainstem.

- Changes to seasonal and longer term recruitment of coarse sediments (spawning gravels) from operation of the FCRPS and tributary dams (Condit and Powerdale dams).

Pacific Lamprey

Without better knowledge of the distribution and duration of residency at different life stages, describing explicit factors in Bonneville Reservoir that limit the production of Pacific lamprey is difficult. Out-of-basin factors impacting Pacific lamprey are present at Bonneville and The Dalles dams, where passage measures developed for salmonids do not necessarily provide optimum benefits to migrating juvenile and adult lampreys.

If adults overwinter in the reservoir, holding conditions are assumed to be adequate in terms of availability of boulder habitat, and water temperature and quality. The availability of fine sediments is extensive in the reservoir. However, the frequent pool elevation fluctuations are likely to negatively impact the ability of juveniles to use nearshore substrates for sustained periods. Juveniles are likely to be susceptible to contaminants because they rear in fine substrates for prolonged periods. Catastrophic events such as chemical spills have the potential to impact lampreys more greatly than other fishes, because multiple year classes coexist in freshwater habitats, and die offs can contribute greatly to population instability.

Bald Eagle

Generally, factors that can limit production of bald eagles include human-related killing, poisoning, habitat destruction and alteration, changes to prey base, and disturbance by humans. Based on the fact that the number of bald eagles appears to be increasing in the Columbia Gorge subbasin, working hypotheses (assumptions) used to suggest potential limiting factors include:

- Contaminants in fish and waterfowl eaten by bald eagles appear to be low enough so reproductive potential of mature birds persists.

- Purposeful (illegal) killing of birds if it still exists, is presently low enough so survivorship of mature birds is adequate to sustain existing population levels in the Columbia Gorge subbasin.

- Availability of forage appears to be adequate to sustain existing population levels in the Columbia Gorge subbasin.

- Availability of perching, roosting, and nesting sites appears to be adequate to support existing population levels.

- Perching, roosting, and nesting habitat closest to water (including islands) represents optimum habitat.

Western Pond Turtle

The western pond turtle has a long life span, requires 10 or more years to reach reproductive age, and has a low rate of recruitment. The vagaries of Pacific Northwest weather probably result in high variation in hatching success. The combination of these factors makes this species especially sensitive to any increase in chronic sources of mortality or other factors that affect reproduction and recruitment.

Human population increases and concomitant development will continue to alter or eliminate habitat for nesting, increase the rate of predation on nesting females, nests, or hatchlings, and/or expose hatchlings to hazardous post-hatching conditions. Alteration of aquatic habitats, by water diversion projects or similar situations, may impose considerable hazard and hardship on moving turtles and result in higher than normal levels of mortality.

Introduced species have changed the ecological environment in the region for pond turtles. As significant predators on hatchling and small juvenile western pond turtles, non-native species such as bullfrogs and warm water fish seem to reduce survivorship and alter recruitment patterns.

The western pond turtle appears to be relatively sensitive to disturbance. Disturbance may affect the frequency and duration of basking or foraging behavior, which may be particularly important for gravid females. Interruption of basking may lead to a delay in the maturation and deposition of eggs, leading to a decrease in hatching success or overwinter survival. Boat traffic and fishing may influence western pond turtle behavior or cause direct mortality.

1.2 Management Plan

The management plan builds on information in the assessment and inventory, expresses the subbasin vision, and proposes biological objectives, strategies, and research, monitoring, and evaluation needs.

1.2.1 Vision

"An ecosystem with productive and sustainable levels of fish and wildlife that provide substantial and sustainable environmental, cultural, recreational, and economic benefits"

Stakeholders representing local, state, and federal entities in the Oregon portion of the lower Columbia River Gorge crafted the vision for the management of fish and wildlife and their habitats.

1.2.2 Biological Objectives and Strategies

Biological objectives based on the vision statement were developed for each focal species. Objectives explain how limiting factors will be addressed and describe the resulting changes in biological performance of the focal species. Strategies are directly linked to achieving biological objectives. Strategies are prioritized as follows:

Urgent needs: These strategies must be continued or implemented as soon as possible to achieve objectives and/or curtail losses.

High priority needs: These are part of a longer view to achieve objectives, but failure to continue or medium-term delays in implementation will not result in immediate or irrecoverable losses.

Information needed: These strategies may have strong merit in particular circumstances, but the benefits and risks need to be investigated to understand details of implementation or potential conflicts with other objectives or strategies.

White Sturgeon

Objectives

1) Optimum sustainable yield. Continue to manage fisheries to attain a maximum harvest rate that allows broodstock abundance to maintain or increase while taking the maximum yield of desirable size classes of fish.
2) Productivity. Attain a level of production (natural recruitment and individual growth) that would allow the sustainable consumptive harvest of 5 kg/ha as suggested in Beamesderfer et al. (1995).
3) Ensure continued progress toward Tribal goals. Quoted from CRITFC (1995):

   "Objectives
   - Within 7 years, halt the declining trends in salmon, sturgeon, and lamprey populations upstream of Bonneville Dam.
   - Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.
   - Restore anadromous fishes to historical abundance in perpetuity."
4) Regular annual recruitment. Provide habitat conditions that will allow white sturgeon spawning and suitable rearing conditions for larvae and juveniles.
5) Increase broodstock abundance. Determine a target level of broodstock abundance, or a target level of annual increase in broodstock abundance, or a combination of the two.
6) Maintain sturgeon that are fit for harvest and consumption. Provide reservoir conditions (sediments and water) that meet Federal and State agency regulations for contaminant levels.

Strategies

Manage white sturgeon in Bonneville Reservoir for sustainable harvest. Urgent need.

Ensure water quality and contaminant loads in reservoir substrates meet existing guidelines and regulations. Urgent need.

Operate the hydrosytem to ensure habitat is available for spawning and rearing white sturgeon. High priority need.

Provide passage facilities or transplant operations that offset the observed net downstream movement white sturgeon and ensure opportunities for genetic interchange.
Information needed.

Consider Bonneville Reservoir as a potential donor population for upstream areas that have reduced productivity or are at risk due to recruitment limitations. Information needed.

Consider transplants into Bonneville Reservoir or hatchery supplementation if prolonged recruitment failures pose risks to white sturgeon productivity in Bonneville Reservoir.
Information needed.

Chum Salmon

Objectives

1) Reestablish at least one chum salmon spawning population upstream from Bonneville Dam. This objective is consistent with and supportive of recovery goals being developed by the NOAA Fisheries' Willamette/Lower Columbia River Technical Recovery Team for ESA-listed salmonids. It is also consistent subbasin plan objectives for the Wind River.
2) Ensure continued progress toward Tribal goals. Quoted from CRITFC (1995):

   "Objectives
   - Within 7 years, halt the declining trends in salmon, sturgeon, and lamprey populations upstream of Bonneville Dam.
   - Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.
   - Restore anadromous fishes to historical abundance in perpetuity."

Strategies

Provide suitable reservoir conditions for passage, adult holding, and juvenile rearing that allow adjoining tributaries (particularly the Wind River) to maintain or reestablish chum salmon production. Urgent need.

Provide suitable spawning habitat within Bonneville Reservoir. Information needed.

Pacific Lamprey

Objectives

1) Restore Pacific lamprey populations. Attain self-sustaining natural production of Pacific lamprey that provides for fishing opportunities at traditional locations.
2) Ensure continued progress toward Tribal goals. Quoted from CRITFC (1995):

   "Objectives

- Within 7 years, halt the declining trends in salmon, sturgeon, and lamprey populations upstream of Bonneville Dam.
- Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.
- Restore anadromous fishes to historical abundance in perpetuity."

Strategies

Improve passage of adult lamprey at Bonneville and The Dalles dams. Urgent need.

Investigate passage needs for juvenile lamprey at Bonneville and The Dalles dams. Urgent need.

Reduce exposure of juvenile lamprey to contaminants. Urgent need.

Investigate use of Bonneville Reservoir by juvenile lamprey. High priority need.

Minimize stranding of juvenile lamprey. High priority need.

Avoid direct dredging mortality. High priority need.

Protect functioning habitats and restore impaired habitats. High priority need.

Bald Eagle

Objectives

1) Maintain and improve present level of survivorship of mature adults.
2) Increase the number of nesting birds to 23 pairs over the next 15 years (assumes approximate 5% annual increase that has occurred in Oregon continues).
3) Maintain a fledgling rate of at least one juvenile per nest per year.

Strategies

Protect existing perching, roosting, and nesting habitats (breeding territories) from destruction and disturbance in the near term, with emphasis on sites on islands or near the Columbia River shore. Urgent need.

Inventory potential new perching, roosting, and nesting habitats, and establish protection measures. Urgent need.

Manage forests and woodlands for the medium and longer term to compensate for succession of existing perching, roosting, and nesting habitats. High priority need.

Promote public awareness of effects of habitat alteration and disturbance of birds. High priority need.

Continue enforcement of federal and state laws that protect bald eagles. High priority need.

Western Pond Turtle

Objective

<u>Restore western pond turtle populations</u>. Re-establish self-sustaining populations of western pond turtles in the Columbia Gorge.

Strategies

Continue the "head start" program to augment populations. Urgent need.

Improve nesting and foraging habitat through pond and meadow development. High priority need.

Reduce predation by introduced species such as bullfrogs. High priority need.

1.2.3 Research, Monitoring, and Evaluation

Research, monitoring, and evaluation needs related to each focal species have been identified to ensure that critical assumptions are addressed and data gaps filled. Additional research and monitoring studies needed for improved decision making have also been identified.

White Sturgeon

Maintain intensive management of fisheries for impounded white sturgeon populations. Management strategies should be tailored to the unique attributes of each population to optimize production and help offset the effects of hydroelectric system operation on yield.

Continue mark-recapture surveys to estimate population abundance. Surveys are currently conducted in Bonneville, The Dalles, and John Day reservoirs on a three-year rotation.

Continue transplanting up to 10,000 juvenile white sturgeon from populations in Bonneville Reservoir and downstream from Bonneville Dam. Consider transplants from Bonneville Reservoir only if experimental transplants demonstrate that handling mortality is low enough to not offset growth benefits of moving fish to under-seeded pools.

Investigate whether compensatory population responses may be at work in the Bonneville Reservoir white sturgeon population, or other impounded areas. Much more work on white sturgeon growth and population ecology is necessary to achieve a good understanding of compensatory population responses.

Investigate levels of contaminants in sturgeon tissue, assess risks to fish health, and evaluate constraints on population productivity. Contaminant loads may be contributing to observed reduced growth and condition of white sturgeon in Bonneville Reservoir.

Identify habitat requirements of subadult and adult white sturgeon, quantify amounts of suitable habitat, and evaluate constraints on enhancement.

While not employed in Bonneville Reservoir, hatchery technology is a conservation tool that has been employed (e.g., ESA listed white sturgeon in the Kootenai River) in other areas of the

Columbia River basin that should be further refined and evaluated for enhancement of threatened populations of white sturgeon

Investigate the need and potential measures for restoring sturgeon passage upstream and downstream at mainstem dam facilities.

Existing evidence suggests that white sturgeon populations probably mixed throughout the basin historically. Downstream of the Kootenai River population, the Columbia and Snake river populations very likely represent sub-populations created by dam construction, and not genetically isolated units. Improvement of passage around the dams would restore natural gene flow to the population. Unlike salmonid populations, there is probably little risk of genetic impacts due to movement of fish among these artificial groupings.

Consider additional mitigation if, after Zone 6 rearing capacity is saturated, production still falls below levels sustained by the lower river population, which is currently thought to be indicative of pre-impoundment population levels.

Examine the relationships between food values of historically- and currently-available prey species. Develop a bioenergetics analysis of white sturgeon diets and dietary needs. Examine the relationship between food sources and white sturgeon growth.

Chum Salmon

Use existing data for adult passage and population age structure to describe a stock-recruitment relationship for chum salmon upstream from Bonneville Dam.

A stock-recruitment function may allow fisheries managers and recovery planners to characterize population viability and develop quantitative goals for habitat capacity and survival

Describe the distribution and relative density of chum salmon juveniles in the reservoir.

Describe migration and distribution of adult chum salmon upstream from Bonneville Dam.

In areas where chum salmon are found, describe the status and trends in aquatic habitats, water quality, and stream flow.

Identify and monitor habitat quality and changes occurring in areas where chum salmon are found.

Identify areas within the reservoir that support or can support chum salmon spawning.

Experimentally use hatch boxes or other artificial instream incubators to hatch chum salmon in Bonneville Reservoir tributaries.

Experimentally trap and haul adult chum salmon from areas downstream from Bonneville Dam to Bonneville Reservoir tributaries.

Identify opportunities to enhance or develop new spawning habitat for chum salmon within the reservoir.

Pacific Lamprey

Investigate potential measures for enhancing upstream passage of adult Pacific lamprey and downstream passage of juvenile Pacific lamprey at mainstem dam facilities.

Identify areas within Bonneville Reservoir that support or can support Pacific lamprey spawning.

Describe distribution and relative density of juvenile Pacific lamprey in Bonneville Reservoir.

Identify and monitor habitat quality and changes occurring in areas where juvenile Pacific lamprey are found.

Bald Eagle

Continue annual nesting surveys in the Columbia River Gorge National Scenic Area.

Continue bald eagle mid-winter survey each January in the Columbia River Gorge lead by ODFW (1979 - 1983 and 1988 – present).

Inventory existing potential unused breeding territories.

Inventory potential future breeding territories.

Assess habitat capacity for breeding territories and overwintering area.

Identify factors associated with nest failure.

Western Pond Turtle

Continue monitoring the effects of the “head start” program.

Thoroughly survey ponds and wetlands for additional populations of western pond turtles.

2 Introduction

2.1 Description of Planning Entity

The Columbia Gorge Subbasin Plan concerns the mainstem Columbia River between Bonneville and The Dalles dams in western Oregon and Washington. The Oregon Department of Fish and Wildlife (ODFW) is the designated lead entity for developing the plan. ODFW is a co-manager of the fish and wildlife resources of the subbasin. ODFW's mission is to protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations.

2.2 List of Participants

The Columbia Gorge Subbasin spans Oregon and Washington, so coordination among various agencies and tribes of the two states was necessary for the development of this plan. ODFW worked with and/or solicited participation from a Subbasin Planning Team/Technical Work Group that included staff from:

Lower Columbia Fish Recovery Board
Lower Columbia River Estuary Partnership
NOAA Fisheries
U. S. Fish and Wildlife Service
U. S. Forest Service
U. S. Geological Survey
Confederated Tribes of the Warm Springs Reservation of Oregon
Washington Department of Ecology
Washington Department of Fish and Wildlife
Oregon Department of Environmental Quality

In addition to a preliminary meeting to start the planning process, Planning Team/Work Group members were contacted to provide information needed for draft documents, and were provided drafts for review and comment.

Additional contributors of technical information included Jeanette Howard, U.C. Berkeley (the USFWS-sponsored freshwater mussels work group), Jen Stone (the USFWS-sponsored freshwater mussels work group), and Molly Webb, Oregon State University (sturgeon toxin bio-accumulation).

2.3 Stakeholder Involvement Process

Stakeholders in the Columbia Gorge were given an opportunity to provide input on the management plan, particularly on development of the vision statement and selection of focal species. Stakeholders involved were:

City of Cascade Locks
Hood River County Planning
Hood River Soil and Water Conservation District
Port of Cascade Locks
Oregon Department of Parks and Recreation
Oregon Department of Transportation
Union Pacific Railroad

2.4 Overall Approach to the Planning Activity

Because the Columbia Gorge Subbasin is limited to a relatively short reach of the mainstem Columbia River, the subbasin plan will differ in some aspects from plans for more “classic” subbasins. No tributaries are included in this plan. As per guidance provided by the Oregon Coordination Group (OCG), a mainstem subbasin is a Columbia Basin subbasin where the primary water feature is the mainstem Columbia or Snake and where tributaries are few or small. The Columbia Gorge fits this definition.

The following guidelines for mainstem subbasin plans were provided by the OCG, and were closely followed (but not strictly adhered to) in developing the Columbia Gorge Subbasin Plan:

- The focus of mainstem subbasin plans is primarily on habitat rather than system-wide mainstem issues such as passage.
- In mainstem subbasins where there is not a lot to be gained in terms of increased production from habitat restoration or protection, a slimmed-down version of a plan may be a reasonable and prudent option.
- At least, for the fish assessment portion of the subbasin assessment, it should be recognized that the analytical tools available for assessing fish habitat in tributary subbasins (EDT, QHA, etc.) are typically not applicable to mainstem areas and that, as a result, simplified assessments that rely principally on professional judgment may be warranted.
- It is recommended that focal species be limited to those that inhabit the area for a significant period of time during one or more life stages and rely on habitat features provided within the mainstem reach to fulfill life stage-specific biological needs.
- Once focal species are selected the principal task is to identify factors that affect productivity, mortality, and survival of each focal species. These would typically be physical habitat, water quality and quantity, and interaction with other species.

With the above guidelines in mind, the planning activity began with a meeting of the combined Planning Team/Work Group to discuss potential focal species, limiting factors, and current efforts in the subbasin. A draft inventory was developed, and submitted to participants for review, comment, and addition of new information. An overview of the subbasin was drafted, which included information provided by many Planning Team/Work Group members. A list of potential focal species was provided to members for final review and comment, as was a draft of the assessment. The management plan was developed using input from Planning Team/Work Group members and stakeholder participants.

2.5 Process and Schedule for Revising/Updating the Plan

This is a living document. The plan will be reviewed by the ISRP, OCG, Oregon (and Washington) State Agencies, and other interested entities during the public comment period that begins June 4 2004 and ends August 12 2004. We will revise and update the plan as appropriate after comments are received.

3 Subbasin Assessment

This is a working draft of the assessment portion of a subbasin plan for the "Columbia Gorge Mainstem Subbasin" (also referred to as Bonneville Reservoir). This draft builds on the "Draft Bonneville Reservoir Subbasin Summary" prepared for the Northwest Power Planning Council, November 2, 2000, by numerous authors facilitated by the Columbia Basin Fish and Wildlife Authority, as part of the "FY 2001 Columbia Gorge Provincial Review". While information in the subbasin summary is relevant to subbasin planning, this draft attempts to describe more fully the types and conditions of aquatic and terrestrial habitat and its relation to the needs of fish and wildlife throughout their life cycle. It attempts to provide the context through which opportunities for increasing or sustaining fish and wildlife production through habitat protection and restoration can be identified. Assessments of the uplands within this subbasin are presented in other subbasin planning efforts (e.g. Hood, Fifteenmile, and others).

3.1 Subbasin Overview

For the purposes of this assessment, Bonneville Reservoir includes the present wetted channel from the forebay of Bonneville Lock and Dam upstream through the tailrace of The Dalles Dam. It includes the embayments, backwaters, and mouths or lower reaches of tributaries and associated seasonally flooded and riparian lands. Bonneville Dam impounded the Columbia River at river mile (RM) 145 in 1938. The Dalles Dam was built in 1957 at RM 191. Bonneville Reservoir is entirely within the Columbia River Gorge National Scenic Area (Figure 1).

At full pool (22.6 m above sea level), the reservoir is a 75 km long, 7,632-ha impoundment that receives water from the Columbia River Basin upstream of The Dalles Dam, six primary tributaries (Wind, Little White Salmon, White Salmon, Hood, and Klickitat rivers and Fifteenmile Creek), at least a dozen perennial secondary streams, and numerous intermittent or ephemeral streams (Table 1).

The drainage area of the subbasin and its tributaries is about 3,300 square miles, approximately 1.4 percent of the entire Columbia River Basin upstream of Bonneville Dam. The volume of the reservoir is 537,000 acre-feet. Tributaries of the subbasin contribute approximately 3.9% of the discharge through the subbasin.

The climate in the subbasin varies dramatically from west to east and is greatly influenced by the presence of the Cascades mountain range intersected by the Gorge. Seasonal precipitation is lowest during July and August and highest from late fall through early spring (Table 2). Average annual precipitation is greatest in the western end of the subbasin (77.4 in/y) and lowest in the eastern end (14.4 in/y at The Dalles). Average annual maximum and minimum ambient temperatures are similar throughout the subbasin, although higher summer temperatures occur in the east end, and cooler winter and summer temperatures occur in the mid-subbasin. Valley aspect affects ambient temperature and precipitation. Generally, south facing slopes along the Washington shore are drier and warmer than north facing slopes along the Oregon shore, particularly towards the east end of the subbasin. The funneling effect of the Columbia Gorge results in high and persistent east winds during winter and west winds during summer. Wind velocities of 32.2-48.3 km/h may persist for days.

Landscape surrounding Bonneville Reservoir is characterized by steep forested hillsides underlain by basalt up to 1,524 m thick with sedimentary and recent alluvium deposits. Elevations range from about 53 m below mean sea level (the deepest river bed elevation in Bonneville Reservoir) to over 1,150 m on mountains bordering the river just west of Hood River, Oregon. The valley floor is naturally and artificially constrained to various extents throughout the subbasin depending on the slope at and above the shores.

The combined effect of climate, soils, and geology on terrestrial habitat types is manifest in the types of plant communities present along the edges of the subbasin and on its islands (Figures 2-6) (URL: *www.http//nwhi.org/ibis/subbasin/subs3.asp*). Historically (ca 1850), the western third of the subbasin was forested with conifers and hardwoods (e.g., Douglas fir, red alder, and bigleaf maple) with smaller areas of riparian wetlands (e.g., red alder, black cottonwood, bigleaf maple, and Oregon ash) primarily in the current area of Stevenson, Washington. The approximate middle third of the subbasin transitioned from coniferous forest with ponderosa pines to dominant ponderosa pine forest. The eastern-most third of the subbasin changed to grasslands and then to shrub steppe habitat to the east in the vicinity of the The Dalles (sage and bitterbrushes with bunch grasses).

Modern land uses within the subbasin include residential, commercial, and industrial development in urban centers including Stevenson, Home Valley, and Bingen, Washington and Cascade Locks, Hood River, and The Dalles in Oregon. The three Oregon urban centers contain marine industrial sites of varying sizes consisting of maintained harbors, reclaimed building sites, and shoreline moorings. Highway S.R. 14 parallels the north shore throughout the subbasin and Interstate Highway 84 runs along the south shore. The Burlington Northern Railroad runs parallel to the north shore and the Union Pacific Railroad runs along the south shore. These transportation corridors are reinforced by riprap revetments along significant lengths of shoreline. Hydraulic connection beneath portions of the transportation corridor between embayments (and mouths of streams) and the river's mainstem is accomplished through culverts, bridges, and trestles. Agriculture is prominent along the middle and eastern portions of the subbasin, particularly on the southern side of the river. State and federal land ownership along the shoreline throughout the subbasin (including islands) is extensive (Table 3).

Bonneville Reservoir was developed and is operated by the U.S. Army Corps of Engineers for hydropower generation and navigation. Other river uses include recreation (e.g., angling, windsurfing, kite skiing, boating, water skiing, sightseeing, bird watching, swimming, and waterfowl hunting) and tribal commercial, ceremonial, and subsistence fishing.

Since the construction of Bonneville Dam, average daily water temperatures during summer have generally increased and flow has decreased during late spring (Figure 7). The time period and magnitude of the spring freshet has been altered (Figure 8 and Figure 9). Depending on hydro operations, reservoir elevation can vary greatly across years (Figure 10) and on a daily or hourly basis (Figure 11). At increased spill, dissolved gas saturation increases (Figure 12). Gas supersaturation occurs up to and in some years exceeds 115%. Turbidity varies seasonally and among years (Figure 13).

The benthic environment of the reservoir has a range of substrate types and sizes. Fine particles (sand) is the most common throughout the reservoirs and is most abundant between Hood and Klickitat rivers (Table 4). Substrates with organic material are a small component compared to all substrates and are almost absent from Hood River the The Dalles Dam. Course substrates (gravel – boulders) are present mostly between Klickitat River and the The Dalles Dam. Sediment presence at different sizes is important to a number of benthic fish and invertebrate species. Information on water depth in relation to substrate type is an important component that USGS could potential develop, but not at the time of preparation of this assessment (personal communication, J. Hatten, USGS, Willard, Washington).

Chemical contaminants enter the river from spills along the transportation corridors and at the dams . Oregon Department of Human Services advises crayfish and clams collected between Bonneville Dam and Ruckel Creek should not be eaten.

3.2 Fish Species Characterization and Status

A diverse community of fishes exists during at least some life stage in the subbasin. Thirtyseven species in 13 families have been observed (Table 5). Of these, 17 species in six families are exotic or non-native. The eulachon and chum salmon have been extirpated from the subbasin since development of the federal Columbia River power system. The range in trophic levels, habitat use, and spawning behavior of these species reflects the variety of habitats used in the subbasin. Important habitat variables include water velocity, depth, temperature, substrate, chemistry, cover, food base, and interspecific interactions. Most of the species observed remain in the subbasin throughout their life naturally or because they are largely constrained within the barriers presented by Bonneville and The Dalles dams (e.g., white sturgeon). Anadromous fish that primarily use the subbasin as a migration corridor (upstream as adults and downstream as juveniles) include stream-type Chinook and sockeye salmon. Species that may use the subbasin for significant portions of their life history include Pacific lamprey, American shad, bull trout, ocean-type Chinook salmon, coho salmon, and rainbow trout (steelhead).

3.2.1 Species of Particular Significance

Particular significance is placed on a number of species for their important cultural, social, economic, and ecological roles. All species undoubtedly play some ecological role (desirable or undesirable) in the subbasin, but little is known about a number of them and they are not addressed further in this assessment. Table 6 annotates significance placed on select species and characterizes the body of knowledge available to inform decisions on resource management in the subbasin. A more detailed description of the biological situation for these species follows.

Anadromous Species

Over three quarters of a million adult salmonids ascend Bonneville Dam annually (Bonneville Dam counts, 1977 – 2002). Of these, an average of 283,000 fish remain within the reservoir, contributing to fisheries, natural and hatchery production in the tributaries, or perishing during upstream migration (Table 7). Fall Chinook salmon are most abundant, followed by steelhead trout. An average of 42,000 Pacific lamprey (approximately three quarters of the Bonneville Dam count) remain downstream of The Dalles Dam (Table 7). Millions of shad ascend Bonneville Dam each year, but the number that remains in the reservoir is unknown.

Abundance of naturally produced juveniles that out-migrate through the reservoir is not presently addressed in this draft assessment. On average, 33 million hatchery-produced salmonids enter the reservoir from Columbia Gorge tributaries annually (Table 8). The vast majority of these fish are subyearling Chinook salmon, produced primarily at Spring Creek National Fish Hatchery. Yearling Chinook salmon are produced and released from Carson National Fish Hatchery and the Hood River Production Program. Subyearling Chinook and coho salmon (naturally and artificially produced) are presumed to make significant use of rearing and overwintering habitat along the shorelines of the subbasin.

Resident Salmonids

Little is known about the abundance and behavior of bull trout in the subbasin. Counts of bull trout at Powerdale Dam in the lower Hood River (RM 4.5) ranged from 2 in 1993 to 28 in 1999. The fish were predominantly 4 to 6 years old. The largest individual was eight years old with a fork length of 63 cm (Olsen 2003). The recapture of individuals suggests fish were swimming from the Columbia River into the Hood River on a spawning migration. A fish tagged in Hood River was recovered by WDFW personnel in Drano Lake and was observed to be preying on salmon smolts released from Willard and Little White Salmon fish hatcheries (personal communication, J. Byrne, WDFW). Tribal pikeminnow gillnetters also observed a bull trout in Drano Lake, as well as at the mouths of Klickitat River and Herman Creek. Bull trout are present in the West Fork Klickitat River. They may possibly seed the reservoir during spring freshets. Whether they ascend the river from the Klickitat mainstem is questionable because of the presence of some natural waterfalls. Fluvial and adfluvial bull trout have been captured by anglers in the mainstem of the Klickitat River, but their watershed of origin is unknown (personal communication, J. Byrne, WDFW). Adult bull trout have been observed in the White Salmon River downstream of Condit Dam and are presumed to be from the Hood River. Bull trout have been observed at Bonneville Dam in 1941, 1947, 1982, 1986, and 1994 (personal communication, J. Byrne, WDFW). They have been observed in other reaches of the mainstem Columbia River. Radio telemetry studies have documented fish from the Yakima Basin entering the Columbia River. The fish use the mainstem fish passage ways in the upper Columbia River when they swim in and out of the Wenatchee, Entiat, and Methow rivers (ESSA Technologies LTD. 2002). A bull trout was observed in the Smolt Monitoring Program collection facility at John Day Dam, 5/18/2002 (Martinson et al. 2003). Downstream of Bonneville Dam, an adult bull trout was caught by an angler in the lower Sandy River (personal communication, M. Hanson, ODFW).

Populations of sea-run cutthroat trout above Bonneville Dam have experienced passage-related losses for nearly 60 years in addition to losses related to habitat degradation. Nehlsen et al. (1991) considered the Hood River stock “at high risk of extinction”. Annual escapement of adult cutthroat trout past Powerdale Dam on the Hood River ranged from 40-180 fish from 1963-71 (Hooten 1997). After monitoring at Powerdale Dam was reinstated in 1992, four adults were sampled that year and three were sampled in 1997 (Olsen and French, 2000). None were observed during the 1993-1996 and 1998-1999 run years. The highest count was 11 in the 2001 run year (Olsen 2003). Populations from the Wind and Klickitat River have been reported as extirpated (Nehlsen et al. 1991). However, a recent catch of a cutthroat trout in a smolt trap fishing the lower Wind River below Shipherd Falls (Rawding 2000) suggests that a remnant population may still persist in the Wind River subbasin.

Predator Guild

Northern pikeminnow, smallmouth bass, and walleye are top fish predators in the subbasin. Northern pikeminnow are the subject of an extensive predator control effort, and smallmouth bass and walleye support popular recreational fisheries. Walleye are also harvested in commercial fisheries.

The northern pikeminnow is a native cyprinind that is widely distributed throughout the Columbia River basin. Intensive predation by northern pikeminnow on juvenile Pacific salmon has been well documented (Rieman et al. 1991; Vigg et al. 1991; Ward et al. 1995). Abundance of northern pikeminnow in Bonneville Reservoir is greater than that in any other reservoir (Ward et al. 1995; Beamesderfer et al. 1996), with abundance of fish greater than 200 mm fork length estimated to be 312,714 (184,466 – 563,647) in 2003 (ODFW, unpublished data). Approximately 1 million juvenile salmonids were consumed annually by northern pikeminnow in Bonneville Reservoir prior to implementation of the Northern Pikeminnow Management Program (Beamesderfer et al. 1996).

Over 300,000 northern pikeminnow have been removed from Bonneville Reservoir since implementation of the Northern Pikeminnow Management Program in 1990 (ODFW, unpublished data). Annual exploitation rate has averaged approximately 10%, ranging from 6% to 13% since 2000, when the minimum size of northern pikeminnow eligible for program rewards was decreased from 250 to 200 mm fork length. Annual exploitation rate throughout the lower Columbia River Basin has averaged about 12%, resulting in an estimated 25% reduction in predation on juvenile salmonids (Friesen and Ward 1999).

Smallmouth bass are introduced and are also widely distributed throughout the Columbia River basin. Density and abundance of smallmouth bass in Bonneville Reservoir are low relative to most other reservoirs in the lower Columbia River basin (Zimmerman and Parker 1995). Unlike other reservoirs, density of smallmouth bass is highest in the tailrace below The Dalles Dam, lowest in the forebay above Bonneville Dam, and intermediate throughout the remainder of the reservoir (Ward and Zimmerman 1999). Given differences in density (Zimmerman and Parker 1995; Ward and Zimmerman 1999) and reservoir sizes, it is likely that abundance of smallmouth bass greater than 200 mm fork length in Bonneville Reservoir is between 12,000 (estimate for The Dalles Reservoir in 1996; ODFW unpublished data) and 38,000 (estimate for John Day Reservoir in 1986 (Beamesderfer and Rieman 1991).

Crayfish and fish each constitute nearly 50% of the diet of smallmouth bass in lower Columbia River reservoirs, including Bonneville Reservoir (Zimmerman 1999). Sculpins are the primary fish prey, with salmonids comprising about 10-25% of the fish consumed by weight, and about 14% by number. Smallmouth bass consume relatively few juvenile salmonids compared to northern pikeminnow (fish comprise 50-75% of the diet, with salmonids comprising 80-90% of the fish)

Introduced walleye are generally less abundant in lower Columbia Reservoirs than either northern pikeminnow or smallmouth bass, although fluctuations in walleye abundance are common (Tinus and Beamesderfer 1994; Friesen and Ward 2000). Walleye year-class strengths are highly variable, with occasional dominant years (Rieman and Beamesderfer 1990; Friesen and Ward 2000). Walleye may consume as many salmonids per individual as northern pikeminnow (Vigg et al. 1991), but low predator numbers usually preclude extensive losses of juvenile salmonids. Fish comprise almost 100% of the diet in lower Columbia River reservoirs, with salmonids constituting about 14% of the fish by number (Zimmerman 1999). Predation may be much higher in spring, when salmonids constitute almost 60% of the fish by weight.

White Sturgeon

There are 25 sturgeon species worldwide; eight occur in North America. Along the Pacific coast of North America there are two sturgeon species: white sturgeon (*Acipenser transmontanus*) and green sturgeon (*A. medirostris*) (Birstein 1993). White sturgeon are found in the Columbia River system as far upstream as the Kootenai River, which has the only ESA-listed population of white sturgeon. In addition to the mainstem Columbia River, white sturgeon are found in several of its major tributaries, particularly the Snake, Salmon, and Willamette rivers. White sturgeon are the largest freshwater fish species found in North America. They are long-lived (up to 100 years or more), and take many years to reach maturity (up to 25 years). These and other factors make sturgeon populations especially vulnerable to overharvest, and very slow to recover from low population sizes. Columbia River white sturgeon were heavily overfished in the late 1800's, resulting in collapse of populations throughout the basin. Recovery of populations took many years, but harvest fisheries are currently allowed in the Columbia River from McNary Dam downstream, including Bonneville Reservoir.

3.3 Selection of Focal Fish Species

Following is a summary of rationales for selecting focal species in the Columbia River Gorge mainstem subbasin planning area. The rationales draw on the concepts in Table 6 in the present draft assessment.

3.3.1 White Sturgeon

White sturgeon fisheries are intensively managed, and the majority of harvest upstream of Bonneville Dam occurs in Bonneville Reservoir. The animal uses the benthic environment extensively, is long-lived, and matures at comparatively older ages. Its diet is unique compared to other fishes and includes benthic invertebrates, some of which are long-lived bio accumlators (e.g. alien and native mussels). The sturgeon is assumed to be an important indicator of sediment quality. They are largely confined within the reservoir and subject to the environmental conditions unique to that reservoir. The fish is significant to tribal culture. Availability of stock assessment information is considerable.

3.3.2 Chum Salmon

Chum salmon are listed under federal ESA, historically entered the planning area, and are genetically similar to chum in the Bonneville tailrace. Their historic range may contribute importantly to the species' spatial structure and diversity. They spawn in low gradient streams or seeps which may have been inundated or affected by reservoir operations. Juveniles have a different vulnerabililty to environmental stressors than other salmonid species, because of their relative small size at outmigration. The salmonids are significant to tribal culture. If some historical data could be located (in addition to the Bonneville Dam adult counts), recent information could be developed from the assessments of the population in the Bonneville tailrace.

3.3.3 Pacific Lamprey

Pacific lamprey are a state species of concern and have been petitioned to be listed under federal ESA. They have unique adult upstream passage requirements and a prolonged juvenile rearing period in fine substrates. The portion of their life history spent within Bonneville Reservoir is uncertain, but adults are known to stage for a prolonged period, and larvae and ammocoetes have been known to occur in large mainstem river systems. Both adults and juveniles are prey for mammals, birds, and fish. They are significant to tribal culture. Information may be sparse, but some reservoir-specific information can be developed: upstream adult passage counts at dams, adult radio-telemetry work, catches in tributary fish traps, incidental catch of juveniles at mainstem smolt monitoring sites, diet studies of fish predators, and inferences from work in the lower Columbia River Basin and selected areas upstream.

3.4 Significant Fish Species not Proposed to be Focal Species

3.4.1 Predator Guild

The predator guild (northern pikeminnow, smallmouth bass, and walleye) is a significant component of the fish community. Because the pikeminnow is a generalist in its diet and habitat use, appears to maintain a population level at sustained exploitation, and the three predators appear not to have compensated for the annual exploitation of pikeminnow, these three species are not treated as focal species.

3.4.2 American Shad

American shad must obviously have some important significance to the structure and dynamics of the fish community, if for no other reason than it has become the most abundant anadromous species in the reservoir and is introduced. At such great abundance it is difficult to consider how it would be an indicator of ecological health, although a better understanding of its interaction with other species could be important.

3.4.3 Fall Chinook Salmon

Fall Chinook salmon may use the reservoir significantly for juvenile rearing. The degree to which they spawn in the Bonneville Reservoir mainstem is assumed to be minimal. The species is not proposed as a focal species because the relative amount of its life spent in the reservoir is less than the proposed focal species.

3.5 Biology and Ecological Relationships of Fish Focal Species

3.5.1 White sturgeon

The white sturgeon population in Bonneville Reservoir is second only to the population in the unimpounded lower Columbia River below Bonneville Dam in terms of abundance (preliminary results from BPA program 8650 stock assessment in Bonneville Reservoir 2003). Prior to 2004, harvest quotas for Bonneville Reservoir white sturgeon commercial and sport fisheries combined were the highest of the three Zone 6 reservoirs (Table 9; Figure 13). The Bonneville Reservoir population usually has more consistent annual recruitment than the other two Zone 6 populations (Kern et al. 2004). White sturgeon abundance in Bonneville Reservoir since 1976 has steadily increased (Table 10).

Age and Growth

White sturgeon live for many years. Fish in Bonneville Reservoir have been estimated as old as 104 years (Figure 15). Aging techniques are typically based on the methods of Brennan and Cailliet (1989), where thin sections of the pectoral fin ray are mounted to slides and annuli are counted visually. This method is probably the most reliable way to age sturgeon, however, agreement among readers aging the same fish is often poor (Kern et al. 2002). Attempts to validate the technique have identified an under-aging bias in Columbia River reservoirs (Rien and Beamesderfer 1994, Kern et al. 2002, Paragamian and Beamesderfer 2003). It may be that sturgeon without access to the ocean do not consistently form annuli. Growth rates in white sturgeon are highly variable, even within year classes. The variability in growth of individual fish makes it impossible to accurately describe annual cohorts over long periods of time.

Growth of white sturgeon has typically been described using the vonBertalannfy model of length-at-age. Using this model of growth, it is assumed that juvenile fish have the highest rates of growth and that the rate of growth declines along a straight line until the growth rate equals zero at the maximum length of the species ($L_{infinity}$). This growth curve yields a length-at-age curve similar to Figure 16. Recent information made available by extensive tag recoveries of fish at large over many years has indicated that the change in growth rate of sturgeon in the impounded reservoirs does not follow this relationship. Rather, sturgeon appear to have several stages of growth (Figure 16). Very little data is available for fish under 70 cm FL or over 150 cm FL. Fish 70-110 cm FL appear to be growing at much slower growth rates than the vonBertalannfy model would predict (Table 11). Conversely, fish between 110-138 cm FL may be growing substantially faster than expected. Harvest guidelines were reduced in 2004 in response to new information showing white sturgeon grow more slowly than previously estimated. The consequence is that fish are vulnerable to harvest for more years than previously believed and exploitation rates needed to be reduced.

Relative weights of white sturgeon in Bonneville Reservoir have consistently been lower than relative weights of fish from the other two Zone 6 reservoirs and the unimpounded lower Columbia River. Relative weights of white sturgeon sampled in Bonneville Reservoir in 1994, 1999, and 2003 were 106%, 88% and 92% respectively (Figure 17; Kern et al. 1999, and ODFW 2003 unpublished data). Relative weight in John Day Reservoir in 2001 was 95% and in The Dalles Reservoir in 2002, relative weight was 104%. The causes of these differences are unclear. Lower relative weight and condition factor in Bonneville Reservoir may be a manifestation of growth compensation due to relatively high fish densities in small size classes.

Duke et al. (1990), Miller et al. (1991), and Parsley and Beckman (1994) stated that growth during the early years of life (ages 1-4) is greater in the three pools above Bonneville Dam than in the river below the dam. Parsley and Beckman (1994) estimated that proportionally more rearing habitat was available in the impounded reaches than in the unimpounded lower river, and suggested that the impounded reaches could support more rearing white sturgeon. They indicated, for example, that densities of benthic invertebrates were higher in The Dalles Reservoir than in the unimpounded river, and suggested that increased growth rates were due to greater food availability.

Movement

Prior to dam construction sub-adult and adult white sturgeon likely moved throughout the Columbia River following migratory prey species (salmonids, eulachon, and Pacific lamprey), or seeking out spawning areas. The extent or timing of these movements is unknown, however movement patterns observed in progressively smaller river systems indicate fish that inhabit smaller reaches (with pools, riffles, and glides) are less mobile than fish in larger reaches. The lower in the Columbia River Basin white sturgeon reside the greater their ranging pattern. Simulations have demonstrated that river fragmentation reduces probability of persistence in white sturgeon (Jager et al. 2001).

Downstream from Bonneville Dam, white sturgeon move widely within and outside of the estuary. Fish tagged in the Columbia River have been recovered in the Fraser and Sacramento rivers. Since completion of the Bonneville and The Dalles dams sturgeon in this reach are functionally trapped within the reservoirs and must derive all of their life history needs within the reservoirs. There is some movement past dams, but most movement is downstream in direction and is primarily comprised of subadults. Primary passage routes may be navigation locks and spill. Bonneville and The Dalles dams historically operated fish lifts that seemed to move white sturgeon effectively.

From 1987 through 2003, 49,000 white sturgeon were tagged in the four lowermost (downstream) Columbia River; of these fish, 6,200 (13%) were recaptured by ODFW. During these years, 6,100 (98%) of these fish were recaptured in the reservoir of original capture and tagging, 106 (2%) were recaptured in downstream reservoirs, and 23 (0.4%) were recovered in an adjacent upstream reservoir (Chris Kern, ODFW, from a presentation at the annual meeting of the Oregon Chapter of the American Fisheries Society, February, 2004). To ensure consistency of mark interpretation and reporting, these data do not include creel survey recoveries. White sturgeon marked in the four reservoirs have been recaptured downstream from Bonneville Dam in the unimpounded section of the Columbia River and in coastal tributaries. From 1988 through 1999, 11,755 white sturgeon were tagged in Bonneville Reservoir. Including creel survey recoveries, 1,161 fish were recaptured during this period: 1,127 (97.8%) were recaptured within the reservoir, 33 (2.8%%) were recaptured downstream from Bonneville Dam, and only 1 (0.1%) was caught upstream from The Dalles Dam (Kern et al. 2002).

Fishway Use

Most passage information prior to 1986 is from Bonneville Dam and is a result of work done by Ivan Donaldson, Corps biologist from 1940-1973. Fish locks at Bonneville were effective in moving sturgeon; with 4,711 moved during 12 years of fish lift operation. Fish ladders were less effective than the lifts were. Typically, fewer than 30 white sturgeon used the ladders at Bonneville annually during a similar time frame. Prior to the modification of fish ladders to include submerged passage routes the situation was even worse for sturgeon attempting to negotiate the dams. Summaries developed by Warren and Beckman (1993) showed passage at viewing windows at Bonneville, The Dalles, and John Day dams totaled 3,464 fish from 1986-1991. Over 90% (3,181 fish) of these occurred at The Dalles Dam. The east ladder at The Dalles accounted for the vast majority of sturgeon passage at this dam, and by extension, the majority of passage at all three dams as well. The authors noted that counts for other species were also higher at this location than at others. Total length of fish using ladders: appears to range from 1 to 7 feet. Most are around 3 feet and this average size is consistent at all three locations. White sturgeon as long as 11 feet have been reported at The Dalles. One fish counter here noted that extremely large fish turned sideways to negotiate the window orifice. Most passage reported appears to have been upstream in direction. This runs counter to information from tag recoveries that document very few tagged fish recaptured in reservoirs upstream from the tagging location - the majority of fish that are recovered outside the marking reservoir are seen downstream from the reservoir they were marked in. Most white sturgeon passage has been observed from May through November. Peak passage is usually in July and August.

It appears that passage counts are currently being collected, but they have not been making it into reports and summaries. Counts of sturgeon are made and entered as comments as time allows in addition to counts of other species (personal communication with Robert Slinson USACE, The Dalles Dam). Recently USACE has agreed to incorporate white sturgeon counts into their data entry and regular reporting of fish passage numbers.

The USACE has also recently funded a study conducted by USGS to investigate behavior of white sturgeon near hydroprojects and fishways at The Dalles Dam. Work is scheduled to begin in March 2004 (study code ADS-04-NEW). Objectives are to 1) Describe the distribution, movements, and behavior of white sturgeon immediately downstream from dams including fish ladder entrances and exits, in fishways, navigation locks, and immediate tailrace areas; and 2) Determine routes of passage taken by downstream migrants and if fallback occurs for fish that ascend fishways.

White sturgeon have been captured incidentally in downstream juvenile salmonid bypass facilities. The sizes of these fish were not documented, but because fish entering the bypass are typically graded by size before being examined, the fish were likely small juveniles.

White sturgeon are not uniformly distributed in Bonneville Reservoir. Densities (inferred from catch rates) were three times greater in the tailrace area immediately below The Dalles Dam than in the rest of the area and densities were lowest in the forebay of Bonneville Dam. White sturgeon of all sizes tended to be distributed more downstream in July than in May, June, July, or September; fish were distributed furthest upstream in September. Fish in Bonneville Reservoir tended to move less than those in The Dalles or John Day reservoirs. Over 50% of recaptured white sturgeon had not moved since tagging and about 80% had moved less than 10 km. Catch rates at different depths were significantly different. Using setlines deployed overnight, catch rates in water less than 10 m deep were lowest, fairly uniform from 10 to 30 m, and greatest at sites >30 m deep, however the size-depth interaction was not statistically significant (North et al. 1993).

Population Genetics

The following quoted text is from LCFRB (2003):

> "Small but significant differences in genetic frequencies and diversity are apparent among white sturgeon populations in the Sacramento, Columbia, and Fraser systems based on electrophoretic and mtDNA analysis (Bartley et al. 1985, Brown et al. 1992, Anders and Powell 2002). White sturgeon populations along the Pacific coast of North America are closely related. Anders and Powell (2002) observed 26 unique mtDNA sequences (haplotypes) in samples from 13 locations in the Columbia, Snake, Kootenai, Fraser, Nechako, and Sacramento Rivers. The two most common haplotypes were represented by 64% of the 260 fish sequenced and were observed at 100% and 85% of the sample sites (Anders and Powell 2002). Similar overlap among populations was reported by Bartley et al. (1985) based on electrophoretic analysis of allele frequencies, Brown et al. (1992) based on mtDNA, and McKay et al. (2002) based on mtDNA. Expansive haplotype distribution indicates little genetic divergence and significant gene flow throughout a major portion of the species' range (Anders and Powell 2002). However, there is little evidence to support high

levels of contemporary gene flow, especially in post-impoundment systems (Anders, personal communication). This conclusion is consistent with observed recaptures of small numbers of tagged Columbia River sturgeon in the Sacramento and Fraser Rivers (DeVore et al. 1999)."

"White sturgeon genetic studies have consistently documented decreasing diversity with distance upstream (Bartley et al. 1985, Brannon et al. 1987, Brown et al. 1992, Anders and Powell 2002). Total number of haplotypes were negatively correlated with inland distance from the Pacific Ocean in all river systems studied (Anders and Powell 2002). Genetic differences were most pronounced in the Kootenai River white sturgeon population where heterozygosity was the lowest observed in the Kootenai River (Bartley et al. 1985, Brannon et al. 1987, Setter and Brannon 1990, Anders and Powell 2002). Kootenai River white sturgeon are believed to be a post-glacially isolated population of ancestral Columbia River stock (Duke et al. 1999; USFWS 1999). This population was listed in 1994 as endangered under the ESA (USFWS 1994)."

"Sturgeon populations impounded in the lower Columbia River mainstem between Bonneville Dam and the Snake River were created by dam construction and do not represent unique genetic units."

Spawning and Reproduction

Available spawning habitat area and the quality of spawning habitat increase with discharge. In Bonneville Reservoir little spawning habitat is available at flows less than 125 Kcfs and high-quality habitat first becomes available at flows >150 Kcfs. Simulations show that quantity and quality of white sturgeon spawning habitat improve with increasing discharge through 500 Kcfs, which is the upper limit of field data collected to date (Parsley and Beckman 1994). These data and simulations were used to recommend that spring hydrosystem operations "maintain a minimum instantaneous river discharge of 250,000 cfs during the time period when river temperatures are between 13 and 15° C. The reservoir forebay elevation at John Day Dam should be kept at or lower than 264 ft above mean sea level. This discharge is the lowest discharge we simulated that provided water velocities we deemed were best suited for spawning white sturgeon. Greater discharges would provide more habitat, lesser discharges would not provide any areas with what we have defined as high quality spawning habitat" in a memorandum to sturgeon project cooperators regarding discharges and sturgeon spawning habitat, dated June 8, 1993, from Mike Parsley, U.S. Fish and Wildlife Service Biologist, Cook, Washington.

A recent hypothesis proposed in Coutant (2004) suggests that riparian areas may provide important habitat for newly spawned eggs and emerging larvae. If substantiated, this theory could identify a limiting factor in white sturgeon spawning success. Riparian flooding is directly related to hydrograph operation and reservoir level.

Based on observed depth and substrate use (Table 12), about 87% of Bonneville Reservoir is usable rearing habitat for young-of-year and juvenile white sturgeon, and 42% of the reservoir is high-quality rearing habitat (Parsley and Beckman 1994).

Spawning and rearing habitat characteristics (depth, velocity, substrate, and temperature) have been described in Bonneville Reservoir (as well as The Dalles, and John Day reservoirs). White sturgeon typically spawn near the bottom in the fastest water available. In Bonneville Reservoir spawning fish and newly spawned eggs have been found in the 8 km downstream from The Dalles Dam. Average depths are 6 m and water velocities near the bottom average 1.4 m/s. Substrates in this highly scoured area are primarily boulder and cobble. White sturgeon in lower Columbia River reservoirs spawn at an average temperature of 14°C (range 10 - 18°C) (Parsley et al.1993, Table 12).

Parsley et al. (1993) correlated white sturgeon spawning in lower Columbia River impoundments with peak river flows during spring and summer. Spawning occurred in the swiftest water available (mean water column velocity, 0.8-2.8 m/s) over substrates mainly comprised of cobble, boulder and bedrock. McCabe and Tracy (1994) concluded that spawning in the lower Columbia river occurred on days with mean discharges ranging between 3,399 to 10,505 m^3/s. Parsley and Beckman (1994) described differences in available spawning habitat downstream of the four dams in the lower Columbia River, and related those differences to channel morphology and river discharge. Little suitable spawning habitat is available downstream of The Dalles, John Day, or McNary dams at flows less than 5,000 m^3/s, while significant habitat is available at much lower flows downstream of the Bonneville Dam. Spawning habitat increases with river discharge, and recruitment is correlated with habitat availability (Parsley and Beckman 1994; DeVore et al. 1997). The relationship between river flow and YOY indexes of recruitment is depicted in Figure 18.

The relationship between substrate and sturgeon selection of spawning sites is not clear. Parsley et al. (1993) collected most newly spawned eggs over cobble and boulder substrates, but also collected some over sand, gravel, and bedrock. Spawning areas usually have larger substrate, but whether sturgeon select for substrate, or the substrate type used is an artifact of water velocity, is unclear.

Quoted from PSMFC (1992):

> "White sturgeon maturation seems to be determined more by size than age in an aquaculture situation (Conte et al. 1988; Doroshov et al 1997). Males mature as early as 3-4 years of age and body weight of 7-14 kg in California culture facilities at water temperatures of approximately 20˚C (Doroshov et al. 1997). Females reared in a hatchery matured at 6-10 years of age, a mean body weight of 32 kg, and a mean fork length of 151 cm (Doroshov et al 1997). Under these conditions, cultured male sturgeon achieved sexual maturity at a similar size and younger age than wild males; age at puberty for females was variable, but cultured females reached sexual maturity at a considerably younger age and size than wild fish. If water temperatures in the hatchery are higher, both sexes are capable of much faster growth in a hatchery than in the wild; puberty and maturation can be accelerated by intensive culture using artificial feed and warm water.
>
> In the wild, the size or age of first maturity is extremely variable. Wild males begin to mature at about 49 in (125 cm) and 26 lb (12 kg) as 12-year-old fish. In the Snake River, some males may mature at 28 in (71 cm) and about 2.4 lb (1 kg; Cochnauer 1981). Male white sturgeon in San Francisco Bay mature at 75 to 105 cm (Chapman, et al. 1996). Females require a longer period to mature, generally 15-32 years. A few fish mature as younger, smaller fish, but an increasing proportion of the population matures as size and age increase (Beamesderfer et al. 1989, 1990a). In the lower Columbia River 95% of female white sturgeon mature between 124 and 196 cm, corresponding to an age of 16 to

35 years (Welsh and Beamsesderfer 1993; DeVore et al. 1995). Welch and Beamesderfer (1993) estimated median length-at-maturity of 165 cm for female sturgeon in the Bonneville and The Dalles reservoirs, and 193 cm for female sturgeon in the John Day Reservoir. In San Francisco Bay recruitment to puberty for female white sturgeon occurs from 95 to 135 cm (Chapman, et al. 1996). In the Columbia River, the relationship between the mature proportion of the population and fish size or age is roughly a sigmoid curve (Welch and Beamesderfer 1993). In the same river, isolated populations that grow slowly, such as the population in Bonneville Pool, seem to mature at smaller sizes and older ages (Welch and Beamesderfer 1993)."

"Throughout their range, white sturgeon spawn between February and July, although North et al. (1993) detected female sturgeon with ripe eggs in the three lowest Columbia River impoundments as late as September. Most spawning occurs when water temperatures are 50-63^{o} F (10-17^{o} C; range of 9-21^{o} C). Buddington (1991) suggested survivorship of embryonic sturgeon decreases outside the 14-16˚C temperature range, and that female sturgeon limit spawning activities to periods when temperature conditions are suitable for development of the early life stages.

In the wild, eggs and sperm are broadcast in fast water. The fast water disperses the adhesive eggs and prevents them from clumping and smothering each other. Limited observations suggest most spawning sites are more than 10 ft (3 m) deep and over cobble substrate (Galbreath 1979; Doroshov 1985; Beckman 1989). Parsley et al. (1989) described surfacing and breaching behavior in The Dalles Dam tailrace, believed to be associated with spawning. Parsley and Beckman (1993) reported observations of spawning activity at a location where water depth was approximately 7 m.

The dark gray 0.10-0.16 in (2.5-4 mm) diameter eggs become adhesive in the water and sink (Stockley 1981; Cherr and Clark 1985; Wang et al. 1985). Calcium and magnesium ions in the water enhance the formation of the adhesive jelly and the sperm's acrosome (Cherr and Clark 1985). Suspended sediment, tannic acid, sodium chloride, or sodium sulfate reduce the adhesiveness of the eggs (Doroshov 1985; Conte et al. 1988).

Whether fertilization takes place in the water column or on the stream bottom is unknown. The opportunity for fertilization is relatively high, as each egg has 5-40 micropyles and the sperm remains mobile for 3-5 minutes (Cherr and Clark 1985).

Eggs remain adhesive for less than three hours (Parsley et al. 1989). If disturbed by changes in flow or other stirring action, they may be dislodged from the bottom (Parsley et al. 1989).

The incubation period is 7-14 days, depending on water temperature (Bajkov 1949; Wang et al. 1985; Conte et al. 1988). Cultured broods tend to hatch synchronously (Conte et al. 1988). Hatching is complete within 20-48 hours (Cech et al. 1984; Doroshov 1985). Most hatching occurs in darkness in the laboratory and may represent adaptive avoidance of visual predators (Brannon et al. 1986). The optimum incubation temperature for subsequent larval viability in a culture situation is 52-63^{o} F (11-17^{o} C; Wang et al. 1987). Higher temperatures of 17-20^{o} C result in higher mortality and hatching at earlier developmental stages (Wang et al. 1985, 1987).

Hatch rates in the wild are unknown. One of the factors potentially influencing egg survival may be the concentrations of toxins in the embryo and yolk (Bosley and Gately 1981; Apperson and Anders 1990).

The black 10 mm larvae are planktonic and drift downstream (Kohlhorst 1976; Stockley 1981; McCabe et al. 1989; Duke et al. 1990). Although larvae have been collected in the field, laboratory experiments provide more complete descriptions of larval development and behavior. The events described below are based on laboratory research. However, Duke et al. (1990) and Miller et al. (1991) described downstream distribution of larvae and young-of-the-year from the spawning grounds."

Feeding

Quoted from PSMFC (1992):

"Sturgeon are opportunistic feeders, using foods that are readily available (Turner and Kelley 1966; Buddington and Christofferson 1985; Buddington and Doroshov 1986a). Diets include mollusks, worms, crustaceans, and fish (Galbreath 1979). Sturgeon also ingest plant material, but scientists feel sturgeon ingest this plant material incidentally (Semakula and Larkin 1968; Cochnauer 1983).

Larvae have teeth until metamorphosis, which may imply carnivorous feeding habits (Brannon et al. 1984) or a phylogenic connection to carnivorous feeding habits (J. DeVore, WDFW, pers. commun.). The composition of digestive enzymes in the gut of white sturgeon is also typical of carnivores (Buddington and Doroshov 1986a; 1986b). Larvae readily take certain live foods, or extracts from them.

Benthos or periphyton probably dominate the diet of larval white sturgeon (Brannon et al. 1984), but they may also feed on pelagic zooplankton (Buddington and Christofferson 1985). There are no field studies on feeding habits of wild sturgeon larvae.

YOY white sturgeon less than 20 cm begin feeding on small (1-3 mm). They seek various aquatic insect larvae as they become larger (Bajkov 1949; Galbreath 1979; Cochnauer 1983; Conte et al. 1988). Common foods also include two species of Corophium. *Corophium salmonis* was the most important food item for sturgeon <72 cm FL in the lower Columbia River (McCabe and Hinton 1990; McCabe et al. 1993) even though it was not abundant in the benthos during the periods sampled. The non-native bivalve Corbicula is known to make up a significant portion of the diet of sturgeon in Bonneville Reservoir, although it's relative food value to sturgeon is unknown.

In the laboratory, small sturgeon can capture other sturgeon of similar size or smaller, and are capable of capturing salmonid fry at night (Brannon et al. 1987). Merrell (1961) found that a 54-in (1.37 m) wild white sturgeon that was caught in the Willamette River below Willamette Falls, Oregon, had ingested 14 salmonids ranging from 4-11.5 in (10-29.2 cm) long. Wild sturgeon are known to eat the fry of shad and other species.

Second- and third-year fish (20-60 cm) feed on tube dwelling amphipods, mysids (*Neomysis* sp.), isopods, other benthic invertebrates, and the eggs or fry of other species of fish.

As sturgeon exceed 60 cm, their diets become more diverse and commonly include fish (Muir et al. 1988. Seasonal migrations begin to occur in semi-anadromous populations, which may be associated with the abundance of prey (Bajkov 1951; McKechnie and Fenner 1971; Muir et al. 1988). Seasonally abundant foods include eulachon , lamprey , American shad , northern anchovy, and herring eggs (Bajkov 1951; McKechnie and Fenner 1971; Doroshov 1985). Eulachon may be the most important food item in winter and spring in the lower Columbia River (Bajkov 1949, 1951). Of these seasonal important food resources, only American shad currently ascend the Columbia River past Bonneville Dam in significant numbers. Burrowing Pacific lamprey (Lampetra tridentatus) larvae, and sculpins can provide a source of food throughout the year. Other items in the diet include small mollusks (clams, mussels, or snails), crabs, barnacles, isopods, amphipods, polychaetes, nematodes, aquatic insect larvae, and crayfish (Bajkov 1949; McKechnie and Fenner 1971). Lamprey and salmonid carcasses, and moribund juvenile (not necessarily fry) salmonids also provide seasonal foods (Galbreath 1979).

Landlocked sturgeon eat snails, clams, crayfish, amphipods, shrimp, a variety of aquatic insects, worms, fish, and plant material (Cochnauer 1983; Partridge 1983; Appendix Table A-4 in Duke et al. 1990). Small insects, such as chironomids, sometimes represent the majority of the stomach contents by number or weight (Cochnauer 1983; Partridge 1983)."

Prior to development of the Columbia hydropower system, white sturgeon had free and open access to ocean and estuary habitats. This would have provided a rich food source and the ability to follow seasonally available prey. Additionally, prey species such as Pacific lamprey Lampetra tridentata, Eulachon Thaleichthys pacificus, and native salmonid species have been negatively impacted by hydropower development; either by limiting their movement upstream, by reducing historic abundances, or by some combination of these and other factors. While historic prey sources may be less available as a result of hydropower development, other species have either been introduced, or have become more abundant as a result of reservoir construction. American shad, Walleye, yellow perch, and bass are non-native fishes that are probably taken as prey by white sturgeon. The non-native bivalve *Corbicula* has been found to be a significant portion of the white sturgeon diet in the Columbia River.

The relative food value of various prey items taken historically and after reservoir development is unknown. It is possible that the reduction in availability of anadromous prey species has reduced the overall value available to sturgeon populations even in the presence of abundant non-anadromous species that might provide a higher biomass of prey items.

Habitat Preferences

Quoted from PSMFC (1992):

"Brannon et al. (1984) described the relationship between velocity and larvae seeking the river bottom. If larvae disperse and actively select habitats based on velocity, they may move several times a day because of changes in water velocities caused by tides or operations of hydroelectric dams. Larval sturgeon are found in shallow and deep water (McCabe et al. 1989; McCabe and Hinton 1990). Stockley (1981) found larvae in water 30-65 ft (9-19 m) deep.

The relationships between sturgeon use of areas and the variables of water velocity, temperature, substrate type, and water depth are unclear. Anders (1991) found that focal point velocities used by sturgeon in the Kootenai River ranged from 0.03 to 0.61 mps, with an optimal of 0.25 mps. Many of the areas where sturgeon live have sand substrates, but often little else is available. Water temperature preferences seem to occur, but field research on temperature selection has not been conducted.

Depth preference data are difficult to interpret because of the differences in available habitats between management units. Gear type limitations may explain some of the variation, but it is probably not the only factor influencing the reported data. Additional research is necessary to describe the relationship between sturgeon distribution and water depth.

In the lower Columbia River, McCabe and Hinton (1990) collected YOY white sturgeon (July-October) in water 13-123 ft (4.0-37.5 m) deep. Minimum depths averaged 48 ft (14.7 m) and maximum depths averaged 74 ft (22.6 m).

In a study by Parsley et al. (1989), juvenile sturgeon (8-35 in; 20-90 cm FL) used a wide variety of depths. Juvenile sturgeon were collected in deep water with trawls and in shallow water with gill nets (Parsley et al. 1989). Most (60-85%) of the juvenile sturgeon (about 12-31 in; 30-79 cm FL) were collected in depths from 33-56 ft (10-17 m) with trawl gear in the Bonneville and The Dalles pools in the Columbia River (Parsley et al. 1989; Duke et al. 1990). Trawling was successful 47-75% of the time at other water depths.

Setline data do not demonstrate the same trend in depth distribution for small sturgeon (30-78 cm). Sturgeon <80 cm caught on setlines were not significantly more abundant, based on catch per unit effort (CPUE), at greater depths in either Bonneville or The Dalles Pool (Beamesderfer et al. 1990a). These authors reported a significant relationship between depth and setline CPUE for sturgeon >80 cm. As depth increased up to about 30 m, the CPUE increased. It may be inappropriate to describe this observation as a depth preference, since setlines may attract sturgeon from considerable distances.

Larger fish may hold or rest in deep water (Bajkov 1951; Haynes et al. 1978; Cochnauer 1983). Although sturgeon commonly use deep pools, they also move into shallow water, perhaps on a daily basis (Haynes et al. 1978; Mike Parsley USGS, presentation at 2004 Oregon AFS). Anders (1991) found that the depths used by sturgeon tagged with sonic transmitters ranged from 3 to 30 m (optimum 9 m) in the Kootenai River, and from 10 to 100 m in Kootenay Lake (bimodal optimum 55 and 90 m). Some researchers do not believe water depth is the habitat variable selected; instead food, water temperature, or light avoidance may prompt movement (Haynes et al. 1978; Stockley 1981)."

Mortality

Quoted from PSMFC (1992):

"Annual mortality estimates are not available for sturgeon up to age 5. Some scientists use 0.99 or more as a mortality rate for YOY, although they acknowledge there are no empirical data to support this rate (Galbreath 1979).

Semakula (1963) and Lukens (1985) estimated the instantaneous natural mortality rate (M) as 0.089 for ages 11-27, and 0.13 for ages 6-25, respectively. Apperson and Anders (1990) provided a much lower natural mortality estimate of 0.03 based on the comparison of two studies. However, they believe this represents an underestimate of natural mortality (K. Apperson, IDFG, pers. commun.). DeVore et al. (1995) estimated the instantaneous natural mortality of lower Columbia river white sturgeon as 0.10 for ages 12-29.

Estimates of total annual mortality (A) for white sturgeon age 5 and older range from 0.06-0.35 (Semakula 1963; Kohlhorst 1980; Cochnauer 1983; Lukens 1985; Kohlhorst et al. 1991; Appendix Table A6). Kreitman and James (1988) estimated total annual mortality of 0.39-0.44 for a single size class (fish 36-40 in; 91-102 cm) downstream from Bonneville Dam (Columbia River) in 1987.

Estimates of the total instantaneous rate of mortality (Z) for white sturgeon age 5 and older range from 0.06-0.46 (Semakula 1963; Kohlhorst 1980; Cochnauer 1983; Lukens 1985; Kohlhorst et al. 1991; DeVore et al. 1995; Appendix Table A6).

Estimated rates of exploitation ranged from 0.06-0.35 (Semakula 1963; Kohlhorst 1980; Cochnauer 1983; Lukens 1985; Kreitman and James 1988; Nigro et al. 1988; Kohlhorst et al. 1991; DeVore et al. 1995; Appendix Table A6). All estimated exploitation rates over 0.15 were from the Columbia River Basin."

Predation

Little is known about the impacts of predation on white sturgeon populations. White sturgeon eggs have been found in stomach contents of resident fish species (Miller and Beckman 1995). The USGS has begun predation studies to examine the relationship between larvae and small juvenile white sturgeon and common fish predator species such as catfish, prickly sculpin, and northern pikeminnow (Parsley et al. 2004). Aside from human impacts, white sturgeon are probably not vulnerable to predation after the juvenile stage. At around 3-4 years of age, juvenile sturgeon would reach a relatively large size, preventing predation by all but the largest predators. The only large predators present in Bonneville Reservoir, aside from humans, are larger white sturgeon.

Population Structure

From Beamesderfer et al. (1995):

> "Maximum yield per recruit [from model simulations] was approximately 25% greater in John Day and The Dalles reservoirs than in Bonneville Reservoir. Yield per recruit was greatest among reservoir populations at annual exploitation rates between 5 and 15%. Estimates of sustainable annual yield (kg) based on the number of age-1 recruits estimated in each reservoir were 16,000 (1.90/ha) in Bonneville Reservoir, 5,800 (1.29/ha) in The Dalles Reservoir, and 2,600 (0.12/ha) in John Day Reservoir. Potential yields in the reservoirs were substantially less than in the unimpounded river at current levels of recruitment, whether based on instantaneous mortality rates of sublegal fish similar to the 0.24 estimated in this paper for impounded stocks (295,200 kg or 4.84 kg/ha) or based on the 0.10 used by DeVore et al. (1995) based on fish in the harvestable size range (1,174,500 kg or 19.25 kg/ha)."

Reproductive potential (eggs per recruit) was also substantially lower in the impounded areas than in the unimpounded lower river. Bonneville Reservoir had the lowest reproductive potential among the three Zone 6 reservoirs. Reproductive potential in Bonneville Reservoir was 13% or 57% of the estimates for the unimpounded lower river, depending on mortality rate used in simulations (see preceding paragraph).

Recently, a population model that is independent of aging methodologies has been used to estimate the performance of sturgeon populations over time. This model has been dubbed the "matrix" model (Appendix C in Kern et al. 2002). It consists of a spreadsheet containing the likelihood that a fish of any size between 54 and 300 cm FL will grow at an annual rate of between –2 and 12 cm FL. The likelihood ratios and selected growth rates were derived from tag recapture data. The model also allows removals to harvest and varying levels of natural mortality. Using this model, it is possible to predict the change in population structure and abundance over short periods of time (<10) years without assumptions based on aging. This model is currently being used in conjunction with previously used methods to help managers establish appropriate quotas for Zone 6 fisheries. However, it has thrown some doubt on the previously recommended exploitation rates, and by extension, the previous goal of optimum sustained yield. This has left managers somewhat in limbo as to management goals for the near future.

Population abundance in Bonneville Reservoir has increased steadily since 1976 (Table 10). Most of this increase has been in juvenile and sublegal size classes. Abundance estimates for fish >72-inches total length are less than in 1976 and have fluctuated between 300 and 900 fish since 1989.

Harvest Management

Previous management goals in the Zone 6 reservoirs were based upon modeling of the white sturgeon populations in the reservoirs and exploitation rates needed to achieve modeled optimum yield for each population. Recent findings have identified a need to modify these goals to account for new information, notably, reduced growth rates. However, there is currently no agreement on exactly what those new goals should be. Options that have been discussed include: harvesting "surplus" over the minimum abundance required to maintain current broodstock levels, harvesting "surplus" over the minimum abundance required to increase broodstock levels over time, modifying exploitation targets to account for new growth information, and maintaining "average" harvests from recent years. Many managers and researchers seem to agree that managing for some level of broodstock abundance, either maintenance or some predetermined level of annual or long-term increase, would be a logical goal. This would allow managers to look at the populations in the long-term, rather than reacting semi-annually to short-term changes in abundance. One key component that is missing in this technique is a better understanding of the relationship between broodstock abundance and recruitment. The stock-recruitment relationship for white sturgeon, especially in impounded areas, is poorly understood.

Supplementation

There is currently one licensed private aquaculture facility in the vicinity of Bonneville Reservoir. This operation is permitted by the State of Oregon to rear progeny of broodstock collected from below Bonneville Dam. Juveniles are sold to the aquarium trade, and some are released into the upper Willamette River as mitigation for the loss of reproduction to the lower Columbia River. Currently, none of these operations directly affect the Bonneville Reservoir white sturgeon population.

The White Sturgeon Management Framework Plan (Fickeisen 1985) identified development of white sturgeon aquaculture as a key action to help restore white sturgeon populations above Bonneville Dam. Beginning in 1999, CRITFC and USFWS biologists began development of a hatchery program to supplement poor recruitment in these reservoirs by hatchery spawning of broodstock collected from the wild. Beginning in 2003, juvenile white sturgeon from these activities were available for release to supplement reservoir populations. Twelve thousand young-of-year white sturgeon were released in Rock Island Reservoir in April and May, 2003, and about 8,600 age-1+ juvenile fish were released into Rock Island Reservoir in September, 2003 (personal communication with Kevin Kappenman, CRITFC fisheries biologist). In the same year, funding for the program was eliminated and the project was halted. There are currently no plans to re-establish funding for this program.

Currently there are no supplementation activities conducted in Bonneville Reservoir. A program to transplant juvenile sturgeon from below Bonneville Dam upriver to The Dalles and John Day reservoirs has been ongoing since 1998. There are currently no plans to supplement the Bonneville Reservoir population via this program, although in the past the population has been suggested as a potential donor source for collection of juvenile sturgeon, due to high abundances of juvenile fish.

Contaminants

Many wild fish populations are in decline due to loss of habitat and the presence of contaminants. Contaminants can influence population numbers by lethal effects on individuals or by non-lethal effects (i.e. gene function, cell integrity and metabolism, immune function, behavior) which ultimately can have deleterious effects on growth and reproduction (Heath, 1995). The types of contaminants that are present in the Columbia River Basin are numerous. Polychlorinated biphenyls (PCBs) are persistent, lipophilic contaminants that had a wide range of uses including capacitors and transformers. PCB-containing electrical equipment from dam operations have been disposed of throughout the Columbia River Basin, and several recent studies have revealed the presence of PCBs in sediments and organisms in the river (Foster et al., 2001a and 2001b; DEQ, 2002; EPA, 2002; URS, 2002). The clean up of Bradford Island Landfill (URS, 2002) in Bonneville Reservoir has identified this area as a "hotspot". Organochlorine pesticides have been used extensively in agricultural practices on lands surrounding the Columbia River Basin and are present in run-off. Dioxins and furans originate from a wide variety of domestic and industrial processes, including incineration of plastics, combustion of fossil fuels, and pulp mills (Kime, 1998). Heavy metal pollution is the result of mining and smelting practices as well as natural weathering processes. All of these contaminants are persistent, lipophilic-compounds that bind to organic substrates and remain in sediments for decades potentially building up behind dams and biomagnifying through the food chain. These contaminants have been detected in white sturgeon in the Columbia River Basin (e.g., Kruse, 2000; Foster et al., 2001a and 2001b; EPA, 2002).

Recent studies have revealed elevated levels of environmental toxicants in white sturgeon tissues (mercury and organochlorines) and suggest that contaminants are negatively affecting sturgeon growth and reproduction. Sturgeon are particularly susceptible to bioaccumulation of environmental pollutants because of their life history characteristics (long-lived, late-maturing, benthic association), and the damming of the Columbia River has resulted in increased exposure of sturgeon to contaminants trapped in sediments behind the dams. Tissue samples (liver, gonad, and cheek muscle) from immature white sturgeon in the estuary, Bonneville Reservoir, The Dalles Reservoir, and John Day Reservoir have been collected and analyzed for chlorinated pesticides, PCBs, mercury and physiological, molecular, and biochemical measures of growth and reproductive physiology. The results suggest a link between contaminants, growth, and reproduction (Foster et al., 2001a and b; Webb et al., in prep, Feist et al., in prep). Specifically, sturgeon captured in Bonneville Reservoir were found to have the highest contaminant loads and the lowest plasma triglycerides, condition factor, relative weight, gonadosomatic index, and plasma androgens (testosterone and 11-ketotestosterone in males) compared to the sturgeon in the estuary, The Dalles Reservoir , and John Day Reservoir (Feist et al., in prep; Webb et al., in prep).

Future research is critical to understand the poor growth and reproductive success of Bonneville Reservoir sturgeon and the potential role environmental contaminants play. Bradford Island Landfill has created a known "hotspot", and the effects of the elevated levels of PCBs on growth and reproduction must be evaluated. Determination of the effects of multiple stressors (including potential synergistic effects of contaminants) on the growth and reproductive physiology of white sturgeon by measuring nutritional status, food quality, toxic chemical concentrations, maternal transfer of contaminants, and effects from toxic chemical exposure is essential. Environmental contaminants appear to be an important limiting factor in the successful recruitment of white sturgeon in the Columbia River.

3.5.2 Chum salmon

Abundance and Distribution

Chum salmon are reported to have once migrated up the Columbia River as far as the Walla Walla River, a distance over 300 miles from the ocean (Nehlsen et al. 1991) and were productive in many lower Columbia River tributaries. Runs of nearly 1.4 million fish are believed to have returned annually to the Columbia River. Recently, annual runs averaged 4,000 fish, about 3% of the historic run size (WDFW 2001). Recent production is generally limited to areas downstream of Bonneville Dam although adults continue to be observed ascending Bonneville Dam. All naturally produced chum salmon populations in the Columbia River Basin were listed as threatened under federal ESA August, 1999.

Chum salmon appear to be virtually extirpated from the Columbia River Gorge subbasin, based on long term observations of adult passage at Bonneville Dam (Figure 19). After Bonneville Dam was completed, passage counts were variable ranging from over 5,000 adults in 1941 to less than 100 by 1968. Since 1970, counts have been as low as one and did not exceed 200 until the 2003 run year (326 adults observed passing Bonneville Dam). Few fish were observed passing The Dalles Dam upon its completion and since adult passage counts began in 1957. In Columbia River tributaries in Washington downstream of Bonneville Dam, chum salmon have increased in numbers on average since the early 1980s (Figure 20).

Historical distribution upstream of Bonneville Dam is not well known. Hatchery records indicate chum salmon were present in Herman Creek and near the Little White Salmon Hatchery during the 1930s through 1950s (Myers et al. 2003). The lower reaches of the Wind River in Washington were identified as having potential to support a run of chum salmon during assessments conducted during the 2003 – 2004 NPPC subbasin planning process at levels possibly as high as 400 adult spawners (personal communication, P. Trask, Lower Columbia River Fisheries Recovery Board). The lower Wind River is identified as a candidate for restoration of chum salmon in the tribal recovery plan, "Wy-Kan-Ush-Mi Wa-Kish-Wit" (Spirit of the Salmon, CRITFC, 1995).

Ongoing work by the NOAA Fisheries Willamette-Lower Columbia Technical Recovery Team (NOAAF WLC TRT) places importance on establishing additional populations in historic spawning areas to spread extinction risk across populations and "strata" in the Columbia chum salmon ESU and lead towards recovery and delisting. Provisional historic population structure of chum salmon in the Columbia River Gorge mainstem subbasin is assumed to include Rock, Herman, Gorton, Viento, Lindsey, and Phelps creeks, and Wind, Little White Salmon, White Salmon, and Hood rivers (Myers et al. 2003). Estimating potential population sizes will likely require modeling exercises using surrogate life history information, and is currently being assessed by WDFW, ODFW, and the NOAAF WLC TRT.

Harvest

Chum salmon historically contributed to significant commercial harvests, with estimated catches as high as 426,000 fish in 1942 (WDFW and ODFW 2002). Catches declined substantially during the 1950s and have remained below 4,000 fish per year since 1959, coincident with developing "weak-stock" fishery management principles for chinook and coho salmon. Recently, chum salmon "take" has been managed under federal ESA at incidental harvest impacts less than five percent per year.

Life History

No quantitative life history information is available for chum salmon in the Columbia River Gorge subbasin. Based on observations of adult spawners in the Bonneville Dam tailrace, peak spawning occurs in mid-November to early December (Table 13). Adult fish return primarily at age four. Age structure for the 1995 through 1998 brood years averaged 0.37 age 3, 0.57 age 4, 0.06 age 5, and less than 0.01 age 6. Estimates of peak time of emergence of fry ranged from February 25 (2002 outmigration) to April 4 (1999 outmigration). Juveniles migrated from the spawning areas from February through June at fork lengths averaging 38 – 43 mm (van der Naald et al. 1999, 2000, 2001, 2002, and 2003).

Restoration Potential

Despite potential limiting factors, a number of tributaries in the Columbia Gorge mainstem subbasin have headwaters in large tracts of federally owned land managed by USFS and provide high quality water to lower reaches. The potential to boost anadromous production through improvement of passage conditions has been evidenced by the rapid colonization of spawning coho salmon into Viento and Purham creeks after passage improvements were made (personal communication, S. Pribyl, ODFW). Despite the limited amount of anadromous habitat available within the confines of the natural valley and channel configuration, collectively, the low gradient reaches of a number of tributaries could contribute significantly to the natural production of anadromous fish. If existing habitats cannot be identified and do not exist to protect chum salmon production, more aggressive options may need to be pursued. For example, emergency measures were taken in Hardy Creek, immediately downstream of Bonneville Dam, after the 1996 flood washed out freshwater production habitat. Eroded banks were stabilized, riparian vegetation was replanted, and previous spawning areas were restored. Reclaimed spawning areas provided successful reproduction. Additional actions taken were to create an artificial spawning channel in 2000, watered by diverting a portion of the natural stream flow. To sustain the production potential of the spawning channel, annual precipitation has to be adequate to divert water to the newly created spawning area. The engineering and success of the spawning channel was reported by Uusitalo (2002)

In portions of river systems where, in the short term, little opportunity or likelihood to restore fully functioning natural habitat exists, engineered solutions to create habitat that could allow fish spawning and rearing (without employing traditional hatchery approaches) have been employed to mitigate for fish losses. In response to increasing and persistent impacts to populations to native fish populations in the Columbia River basin, engineered-habitat approaches have been proposed to address factors that limit spawning and rearing success fishes such as the Kootenai River white sturgeon (Anders et al. 2003).

In Canada, artificial streams have been successfully used to increase the productivity of spawning and rearing habitat for salmon (Lister and Finnigan 1997; Cooper 1977). In Europe, where landscapes have been altered, previous to population by Euro-immigrants to North America, by the increasing demands of growing human populations, restoration strategies to protect fish and wildlife resources include engineered habitat to maintain lowland river fishes (Simons et al. 2001). Although the use of engineered habitat during earlier years of hydro-development in the Columbia River basin was not successful in the Columbia River basin (e.g., spawning channels for fall Chinook salmon in the Priest Rapids and McNary dams' tailraces), potential and limited alternatives may exist to contribute to increasing anadromous fish population levels in relatively small areas of habitat in specific areas. For example, a small channel on the Dungeness River in Washington produced juvenile salmonids from natural spawning fish comparable to 10 to 20 square kilometers of watershed area.

3.5.3 Pacific Lamprey

Pacific lamprey are the largest and most abundant lamprey species in the Snake and Columbia River system (Wydoski and Whitney 1979). Adult Pacific lampreys are parasitic, preying on fish in the ocean for one to two years. They migrate into freshwater to spawn, in habitats similar to those used by adult salmonids. When larvae emerge from gravel, they rear in fine sediments for four to six years before metamorphosing into young adults and migrating from freshwater to the ocean. Pacific lampreys are distributed throughout Columbia Basin tributaries upstream to Chief Joseph and Hells Canyon dams. They spawn and rear in the larger tributaries of Bonneville Reservoir and have been observed as juveniles in smaller tributaries (Viento and Purham creeks; personal communication, T. Murtagh, ODFW). A widespread decline in numbers of Pacific lamprey has occurred since the 1960s coincident with completion of the FCRPS. This decline has been attributed to a number of causes, including habitat loss, water pollution, ocean conditions, and dam passage (Close et al., 1995).

Pacific lamprey are ecologically significant to freshwater river systems. Returning adults contribute to nutrient budgets, bringing trace minerals from the ocean to streams and uplands when animals prey or scavenge upon them. They are important forage, both as juveniles and adults, for fish, birds, and mammals. Pacific lampreys are highly regarded as traditional food by Native American tribes. Former lamprey abundance provided both tribal and non-Indian fishing opportunities throughout Columbia River Basin tributaries. Pacific lamprey collection at Willamette Falls for fish food processing in 1913 was documented at 27 tons (CRITFC 1999). Commercial fishermen in the 1940's harvested 40 to 185 tons annually (100,000 to 500,000 adults) at Willamette Falls for use as vitamin oil, protein food for livestock, poultry, and fish meal. Because of declines in abundance, the Willamette River commercial fishery was closed beginning in 2002. In 2003, Pacific lamprey were petitioned to be listed under federal ESA.

Abundance

Although adult lamprey counting at mainstem Columbia and Snake River dams is not standardized, population trends indicate precipitous declines (Table 14). Based on 1997 COE fish ladder passage estimates, there was a 65% drop in Pacific lamprey abundance between Bonneville and The Dalles dams, with another large drop (72%) between John Day and McNary Dam counts. Passage over upriver dams in the Snake and Columbia rivers in 1997 was low. Only 3% of the Pacific lamprey that crossed Bonneville Dam was counted at Lower Granite Dam and approximately 6% crossed Wells Dam in the upper Columbia River.

Habitat requirements of Pacific lamprey share several common features with salmonids. Lamprey build nests in gravel in stream riffles and the eggs develop in the substrate. Cool, clean, well-oxygenated water is required. After spawning, adults die, although limited evidence suggest adults can survive to spawn again (Kostow 2002). After emergence, larval lamprey (ammocoetes) burrow into fine substrates downstream of the redds after hatching and develop for up to 6 years. After residing in freshwater as filter feeders, they begin to migrate to the ocean.

Run Timing

Passage counts at Bonneville Dam showed median passage dates at the end of July (Figure 21). Out-migrating juvenile lampreys have been sampled in abundance at John Day and Bonneville dams. At John Day Dam, two distinct passage peaks appear to be evident. Martinson et al. (2004) report the following for John Day Dam:

An estimated 21,601 lamprey passed the project through the bypass system May 30. "The most noteworthy passage peak occurred over a three day period, from 7-9 June when an estimated 67,700 lamprey passed the project. Approximately 98.7% of the juvenile lamprey were smolted (macropthalmia), while the remaining 1.3% were ammocoetes in various stages of metamorphosis. The total estimated lamprey collection for 2003 was 191,876, about 69% of last year's estimate of 279,302.

For Bonneville Dam, Martinson et al. (2004) report: "Pacific lamprey juveniles were found in samples from March through October. Although juvenile lamprey were sampled in every month of the season, there were three distinct peaks; 10 June (6,800), 12 June, (2,500) and 14 June (3,400). These are collection estimates generated from the sample rate and represent the estimated number passing through the bypass system that day. Almost 65% (19,679) of juvenile lamprey passage occurred in June and 97% (30,206) of the run had passed the facility by the end of June. The total collection estimate for the season was 30,333, of which over 99.4% were smolted. This season's (2003) collection estimate is about 135% of last year's total of 22,443."

Habitat Use

Current knowledge of habitat use of juvenile Pacific lamprey is mainly limited to tributaries of the Columbia and Snake rivers (Kan 1975; CRITFC 1999. Other than upstream and downstream migration, specific habitat use by location, duration, and life stage in Bonneville Reservoir is not well known. Some observations of mainstem habitat use have been made where water surface elevations were rapidly lowered via manipulation of base flows by hydroelectric dams. Several juvenile lamprey were exposed during the test drawdown of Little Goose and Lower Granite dams in March 1992 (Dauble and Geist, 1992). An investigation of substrates in the lower reach of Fifteenmile Creek and its confluence with the Columbia River mainstem identified the presence of larval lamprey at densities up to 117 fish/m^2 in depths ranging from 0.5 to 3.2 m (personal communication, J. Smith, InterFluve Company). The fish were well distributed across body lengths, suggesting the presence of multiple year classes. In the lower Willamette River, age 0+ lampreys of unknown species have been observed in sandy substrates at a depth of 45 ft (personal communication, T. Friesen, ODFW). Juvenile lampreys have been observed most months of the year in a variety of nearshore habitats in the lower Willamette River.

3.6 Wildlife Species Characterization and Status

Because information on population dynamics is often lacking or less detailed for non-game wildlife compared to fish species, this assessment is less detailed. This assessment attempts to use the NPPC-sponsored Interactive Biodiversity Information System (IBIS) to characterize wildlife habitat types and long term changes at a broad scale. Also, because the numbers of species are large, the scope of the assessment is narrowed by identifying focal species that rely on habitats that are unique to Bonneville Reservoir, and depend on both aquatic and terrestrial habitats. Inventorying habitat structure or quantifying “key ecological functions” is beyond the scope of this draft subbasin plan. However, these principals are discussed briefly using Wells Island as an example.

3.6.1 Wildlife Habitats

Since modern development began in the Columbia Gorge, substantial changes to habitat types and quantities have occurred (Table 19). The spatial resolution of habitat types in IBIS appears to be different across the time periods and quantities of habitat types should be considered cautiously. On a broad scale, the amount of riparian wetlands has decreased and been converted to urban mixed environs in the west end of the Gorge, and to interior grasslands in the east end of the Gorge. In the southeast portion of the Gorge at higher elevations, montane mixed conifer forest has changed to mesic lowland conifer-hardwood forest. In the east end, interior mixed conifer forest has changed to westside oak and dry douglas forest. Some interior grasslands have changed to shrub-steppe. Current habitats include the urban and mixed environments and agriculture in the Hood River area which was historically forested, and the change of interior grasslands into urban and mixed environs and agriculture in The Dalles area.

Current land ownership by habitat type and quantity is shown in Table 20. Approximately 36% of the Columbia Gorge (including uplands) is in federal, state, and tribal ownership, 58% is in local government and private ownership. Six percent of the Columbia Gorge is the open water of Bonneville Reservoir. Mesic lowland conifer-hardwood forests represent almost half of the wildlife habitat in the Gorge and more than half is in federal and state ownerships including the U.S. Forest Service administered Mt. Hood and Gifford Pinchot National forests and Oregon state parks. Wetland habitats are a small portion of the habitat types and are primarily in private ownerships. In areas outside the urban centers, approximately half of the Oregon portion of the Bonneville Reservoir shoreline (not including islands) is within federal or state ownership and approximately one-third of the Washington shoreline (Table 3)

Over 250 wildlife species were identified that use habitat in the Bonneville Reservoir area – 52 mammals, 181 birds, 12 amphibians, and 14 reptiles (Rasmussen and Wright 1990). When

Bonneville Dam was constructed, Rasmussen and Wright (1990) estimate that over 12,000 acres of prime wildlife habitat were lost.

3.7 Selection of Focal Wildlife Species

Presently, the general rationale for selecting wildlife focal species is 1) will they be represented at the ecoprovince level through other subbasin planning efforts, and 2) is it obligate to unique habitat types in the planning area. Two species are presently included. Others could be considered if sufficient knowledge were available to address them.

3.7.1 Bald Eagle

Bald eagles nest, forage, and overwinter in the Columbia Gorge Ecoprovince. They are listed under state and federal ESAs and are of national cultural significance. They have a direct link to aquatic resources (e.g., they prey on fish and waterfowl). They have an important ecological role by contributing marine nutrients to uplands. They can be an important indicator of forest structure (availability of large trees for nest sites and roosts) and water quality (they are relatively long-lived and susceptible to contaminants accumulated in their prey).

3.7.2 Western Pond Turtle

The western pond turtle is declining throughout most of its range, is highly vulnerable to extirpation in Oregon and Washington, and has been extirpated from most of its range already. As a result, the western pond turtle has been listed as endangered by the state of Washington. Three populations remain in the Columbia River Gorge, two in Washington and one in Oregon. The total number of western pond turtles in known Washington populations is estimated at only 250-350 individuals, many of which went through the head-start program at the Woodland Park and Oregon zoos. Additional turtles may still occur in wetlands that have not been surveyed. The species requires a continued recovery program to ensure its survival until sources of excessive mortality can be reduced or eliminated.

3.8 Significant Wildlife Species not Proposed to be Focal Species

3.8.1 Blue Heron

Blue herons have had rookeries in the planning area and have a link with the aquatic environment through their foraging behavior. Their preference for trees and a particular woodland structure for nesting monitors forest succession.

3.8.2 Purple Martin

Purple martins have unique habitat requirements for nesting. They require nest cavities in trees, and optimal locations are in open stands of flooded timber close to aquatic insect production that provides forage. Colonies of purple martins occur in the Columbia River Gorge. They have not been selected as a focal species in this assessment but are addressed in the Hood River subbasin planning process.

3.8.3 Painted Turtle

Painted turtles have been observed in the Columbia River Gorge (personal communication S. Vrilakas, Oregon Natural Heritage Institute). This species was not addressed further. Rather the western pond turtle was selected because of its endangered status in Washington and sensitive status in Oregon. Population data is more extensive for western pond turtles than for the painted turtle in the Columbia River Gorge.

3.9 Biology and Ecological Relationships of Wildlife Focal Species

3.9.1 Bald Eagle

The bald eagle was listed as a threatened species under the federal ESA in 1978 in the Pacific Northwest. It is a State Threatened species in Oregon and Washington. It is vulnerable to loss of nesting and winter roost habitat, and is sensitive to human disturbance from residential development and timber harvest along shorelines; however, bald eagle populations are recovering toward target levels established by the Pacific States Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service 1986).

Bald eagles are found along marine shorelines and the shorelines of freshwater lakes and rivers. Eagles defend breeding territories to protect their preferred feeding sites and nest, perch, and roost trees (Stalmaster 1987). In the Columbia River Gorge, breeding territories include upland woodlands and lowland riparian stands with a mature conifer or hardwood component (Grubb 1976, Garrett et al. 1993, Watson and Pierce 1998). Structural characteristics of many nesting sites are typified by large mature or old growth individual hardwood or conifer trees that are significantly taller than the surrounding tree canopy or area (Stahlmaster 1987). Territory size and configuration are influenced by a variety of factors, including breeding density (Gerrard and Bortolotti 1988) and the types of foraging habitat and prey that are available (Watson and Pierce 1998).

Bald eagles are common in the Columbia Gorge subbasin during the winter months (December – March). Bald eagle nesting and foraging habitat has been reduced since inundation of the river in the Columbia River Gorge by Bonneville Dam. In addition, the primary fishery resource has diminished with declines in salmon numbers. The historic size of the breeding population in the Columbia Gorge is unknown. No known bald eagle nesting territories existed along the Bonneville Reservoir based on surveys done during the 1980's.

The breeding population in Oregon statewide and along the Columbia River has increased dramatically over the last two decades (Figure 22). In Oregon, the productivity rate (young per occupied territory) has averaged 0.97 since 1971. Productivity in territories along the Columbia River (Columbia River Recovery Zone 10) has been less at a rate of 0.81 since 1973 (Isaacs and Anthony, 2003). In the Columbia River Gorge (Hood River, Skamania, Klickitat, and portions of Multnomah and Wasco counties) productivity since the early 1990's has averaged slightly more than one young per occupied territory (1.07) and has been higher than the statewide and Columbia River average for the same period (0.99 and 0.88). The nesting success rate in the Columbia River Gorge has averaged approximately two-thirds.

3.9.2 Western Pond Turtle

Western pond turtles are considered because they have habitat requirements that are both aquatic and terrestrial. For three populations to exist in upland ponds in Hood River, Klickitat, and Skamania counties, turtles dispersed by land or water and have habitat needs historically filled by the riparian areas of the planning area.

Abundance and Distribution

The Klickitat population was estimated to total about 108 turtles in 1986 (Zimmerman 1986). At the beginning of 1990, the Klickitat County population was estimated to number between 60-80 animals (Holland 1991a). Subsequent data indicate the 1990 population was over 96 turtles. Measurements of carapace lengths indicated the population was moderately adult-biased, with about 78% of the animals over 4.5 in (120 mm) (Holland 1991a), compared to 55-70% under normal circumstances (Holland and Bury 1998). This indicated that recruitment may be low and the population may be in decline (Holland 1991a).

The Skamania County population was surveyed repeatedly between 1990 and 1994 (Scott 1995b). During 1992 surveys, 26 turtles were detected at 12 sites, and during 1994, 39 turtles were found at over 14 different sites. The 1994 estimate for Skamania and Klickitat Counties combined was 156 turtles (39 in Skamania County, 117 in Klickitat County).

In contrast to the two Washington turtle populations, the Oregon population south of Mosier appears to be sustaining itself through natural recruitment. The age structure is approximately 55 % adults and the remainder is juveniles, suggesting the population remains relatively undisturbed. The population is protected through a local turtle management plan (Dobson 1995) as specified in Wasco County ordinances 14.410,C,3(e).

Genetics

Gray (1995) found that turtles in the Columbia Gorge had very high genetic similarity within sites and significant genetic divergence among sites. Results indicated a lack of dispersal and gene flow between sites. Janzen et al. (1997) evaluated molecular phylogeography of the western pond turtle, and found low levels of genetic differences among populations of northern pond turtles. They conducted a more detailed analysis of turtles in Oregon, and found that there were small genotypic differences within Oregon populations. Of particular note, turtles in the Willamette Valley were slightly different from turtles in the Columbia Gorge.

Reproduction

In Washington's Columbia Gorge populations, most females that were monitored in successive years nested each year. Holland and Bury (1998) report that in northern areas, most females only deposit eggs in alternate years. In central and southern California females produce eggs every year and two clutches in some years (Holland and Bury 1998). Double-clutching by wild females has been observed in Washington during 1996, 1997, and 1998 (K. Slavens, unpubl. data). In Washington, clutches have been laid between May 31 and July 9 (n=41) with a peak in mid-June. Clutch size ranges from 2-13 eggs and is positively correlated with body size. Mean clutch size for 36 wild nests from Washington was 6.64 (SD ±1.57, range 2-10) (F. & K. Slavens, WDFW, unpubl. data).

Causes of Decline

Shallow water habitats created by flooding and seasonal drying of lowland backwater areas along the Columbia River have been severely affected by impoundment of Bonneville Reservoir. These seasonal environments historically were rich in amphibian species (i.e. spotted frog and western toad) that are now primarily missing from the Columbia River lowlands. In addition, the western pond turtle was considered to have been present throughout the lower Columbia River system from The Dalles to the Portland/Vancouver area. It is currently found in a few select upland ponds adjacent to the Columbia River. Recent review of pre-impoundment aerial photographs from the Columbia River indicate a significant loss of wetland habitat considered important to healthy populations of this species. These connected wetland habitats would have provided for more widely distributed populations of western pond turtle along the Columbia River.

The initial cause of the decline in western pond turtle numbers in Washington may have been commercial exploitation for food. Western pond turtle populations cannot be sustained under exploitation, due to their low rate of recruitment and lower densities at the northern portion of the range. Pond turtles never recovered from this decline, in part, due to concurrent or subsequent alteration and loss of habitat. Wetlands were filled for residential and industrial development, particularly in the Puget Sound region. Dam construction and water diversion projects reduced available habitat and isolated populations along the Columbia River. Nonnative predators such as bullfrogs and warm-water fish, which were introduced to lakes and ponds, probably took a toll on hatchlings and young turtles. Human disturbance may have kept females from crossing overland to lay eggs, or may have reduced the amount of time spent basking, which in turn, may be important for egg maturation. Loss of lakeside emergent wetland vegetation to grazing and trampling may have made habitat less suitable for hatchlings and juveniles. Successional changes through fire suppression on native grasslands may have resulted in excessive shade on nesting grounds.

Predation

Bullfrogs prey on juvenile western pond turtles (Moyle 1973). Bullfrogs are native to the eastern United States, but have become abundant and widely distributed in the west since their introduction to Idaho in the 1890s, and to Oregon in the 1920s (Lampman 1946). They currently are found throughout the range of the western pond turtle (Bury and Whelan 1985). Bullfrogs may be an important predator on hatchlings because both frequent shallow water habitat. Holland (1991b) has observed a reduction in the abundance of juvenile western pond turtles in areas with bullfrogs. Predation by bullfrogs and other predators may be responsible for the lack of juveniles in many pond turtle populations. Largemouth bass also prey on juvenile pond turtles (Holland 1991b); however, observations by Holland (1991b) indicate that the impact of bass may not be as important as that of bullfrogs, perhaps because bass do not frequent the shallows as much as bullfrogs.

3.10 Aquatic Invertebrate Characterization and Status

Treating selected species of aquatic invertebrates as focal species would be fruitful in assessing the health and quality of unique freshwater habitats in Bonneville Reservoir, but developing the level of information required to address them as focal species was beyond the scope of this subbasin plan. However, some points warrant presentation and discussion. The spread of invasive species is a growing ecological threat in large aquatic systems including the Columbia River basin. Some invertebrates such as freshwater mussels can be important indicators of levels of contamination from toxic chemicals. For example, the introduced Asian clam (*Corbicula* spp) was collected in the Bonneville Dam forebay to assess contamination levels of sediments. The sampling has been completed but the results of tissue assays are not yet complete. The fact that white sturgeon (a long-lived species) prey on Asian clams (another long-lived species) could be consequential to human health concerns if the rate of biomagnification is great.

Also of concern is an apparent decline in native freshwater mussels throughout North America. While quantitative inventories of fresh water mussels in Bonneville Reservoir have not been identified in the assessment, the following general information on freshwater mussel biology is presented.

3.10.1 Native Freshwater Mussels

Background

Freshwater mussel populations throughout the eastern United States and southeastern Canada have abruptly declined in the recent past (see section entitled Causes of Decline below). This alarming loss of species and populations has been documented in numerous studies over the past two decades, with over 70 percent of the species considered either imperiled or extinct (Butler, 1989; Williams et al., 1992; Neves et al., 1997; Brim Box, 1999; Brim Box and Williams, 1999). Extinction rates for freshwater mussels are an order of magnitude higher than expected background levels (Nott et al., 1995). Although the current status of western mussels is unknown, the considerable research on eastern species' population trends (Williams et al., 1992) provides insights into the possible status of western freshwater mussel populations.

Current knowledge of Columbia and Snake River mussel populations (families: Margaritiferidae and Unionidae) is very sparse. Eight recognized species (Turgeon et al., 1998) occurred in the western U.S.; six occurred historically in the mainstem of the Columbia; and five in the mainstem Snake River. Of the six from the Columbia, five are in the family Unionidae: Anodonta californiensis, A. kennerlyi, A. nuttalliana, A. oregonensis, Gonidea angulata and one species in the family Margaritiferidae: Margaritifera falcata. Historic records confirm that all but A. californiensis occurred in the Snake River.

Although a few reports (Mavros et al. 1994; Frest and Johannes, 1995) speculate that much of the mussels' range has been lost in the Columbia and Snake rivers, little in the way of actual basin surveys have been conducted. To understand changes in populations, it is important to compare historic ranges and composition to current distributions. A historic database maintained by the U.S. Forest Service allows researchers to obtain details of mussel occurrence in all western states (per. com Jayne Brim Box, USFS, Logan, UT).

Importance

Mussels were important food for tribal peoples of the Columbia and Snake rivers. Native Americans in the interior Columbia River Basin harvested freshwater mussels for at least 10,000 years (Lyman 1984). Ethnographic surveys of Columbia Basin tribes reported that Native Americans collected mussels in late summer and in late winter through early spring during salmon fishing (Spinden, 1908; Ray, 1933; Post, 1938). Tribal harvesters collected mussels by hand but when wading was not possible they used forked sticks (Post 1938). Mussels were prepared for consumption by baking, broiling, steaming, and drying (Spinden, 1908; Post, 1938). Native American use of freshwater mussels decreased during the last 200 years, probably due to declines in mussel populations (Chatters 1987). A Umatilla tribal elder, however, remembered his parents trading fish for dried mussels as late as the 1930s (per. com. Eli Quaempts, CTUIR tribal member, 1996).

Mussels are dependent on fish hosts for larval stage development (see discussion of life cycle below) (Coker et al., 1921; Matteson, 1955; Fuller, 1974; Oesch, 1984). Thus long-term decimation of mussel populations would result from a substantial and sustained reduction in fish populations, even if habitat for mussels remains favorable (Watters, 1992; Haag and Warren, 1998). Correspondingly, mussels provide one path by which declines in fish taxa have propagating effects into other parts of the ecosystem. Anadromous salmonids are known to be hosts to Columbia and Snake river mussel larvae (Karnat and Milleman 1978).

Mussels are sensitive to a variety of watershed environmental changes (Vannote and Minshall, 1982; Williams et al., 1992; Strayer and Ralley, 1993) and this sensitivity makes them ideal biomonitors of the health of the system. Ways in which freshwater mussels can reflect the stream environment include their presence/absence, spatial distribution, population age structure, and tissue and shell chemistry. Mussels are nearly stationary, bottom-dwelling filter feeders, and therefore are vulnerable to alterations of substrate character and suspended sediment concentration, as well as magnitude of riverbed scour and deposition, and pollution (Strayer, 1983; Layzer and Madison, 1995; Brim Box and Mossa, 1999). In addition, the freshwater mussels shell grows by yearly growth increments which enable the age and time of formation to be determined. Many histological changes are preserved in the shell as growth increments, discontinuities, or changes in shell chemistry. These organisms are therefore an excellent archive for studying environmental changes in watersheds.

Because mussels can be surprisingly long-lived (over 100 years for some species including M. falcata) (Hendelberg 1961; Hastie et al., 2000), spatial and temporal comparisons of mussel population age structure may allow important insights into the timing and causes of population changes for a variety of species. A population decline of host fish, for example, without degradation of habitat would result in healthy mussel beds with a relative preponderance of old individuals, whereas habitat degradation would be more likely to decimate populations of all age groups.

Freshwater mussels are often the dominant consumer biomass within streams. As filter feeding grazers, mussels can remove large amounts of particulate matter from the water column and transfer those resources to the substrate as biodeposits (agglutinated mussel feces and pseudofeces). Mussel biodeposits are a nutrient rich and easily assimilated food source and therefore may have significant trophic relevance in the benthic community structure. By converting and transferring food resources in the river system, mussels may provide indirect links among trophic levels, reflected in alterations in macroinvertebrate community structure.

Causes of Decline

Although research on freshwater mussels in this region is sparse, much research has been conducted on the declining mussel populations of the eastern United States. These previous studies illuminate some of the possible causes of changes to mussel populations and demonstrates that, even given the importance of fish populations to mussel health, habitat changes are a very important control on mussel systems (Fuller 1974; Bogan, 1993; Williams et al., 1992; Williams and Fuller, 1992). Population declines are attributed to habitat degradation including direct changes to river channels such as damming, dredging, pollution, and harvesting mussels for commercial use (currently as cultures for the Japanese pearl industry), and indirect changes resulting from land use activities within the terrestrial environment (agricultural activities, logging, urbanization, road construction) (Bogan, 1993;Williams and Fuller, 1992; Williams et al., 1992; Butler, 1993).

In general, four types of environmental factors can affect the structure of freshwater mussel communities: distribution and availability of host fishes (Watters, 1992; Vaughn, 1997; Haag and Warren, 1998); micro-habitat variables such as substrate composition and shear stress (Layzer and Madison, 1995; Morris and Corkum, 1996; Hamilton et al., 1997; Di Maio and Corkum, 1997; Howard and Cuffey, 2003); larger scale drainage basin characteristics such as stream area, contamination (pollutants), and impoundment locations (Watters, 1992; Strayer, 1993; Frazier et al., 1996; Vaughn and Taylor, 1999); and distribution and abundance of exotic competitive species like Asian clams (Fuller and Imlay, 1976; Gardner, et al., 1976; Cooper and Johnson, 1980) zebra mussels (Ricciardi et al., 1998; Schneider et al., 1998). Although a problem in the eastern U.S., to date, zebra mussels are not established in any western streams.

Conclusion

Mussel population inventories in these basins are needed to assess the current status of freshwater mussels and to provide benchmarks from which future changes in mussel population health and age distribution can be inferred. This understanding will assist designs for meaningful monitoring programs for these populations, will contribute to interpretations of population changes, and may ultimately prove important in efforts to preserve these organisms in northwestern streams. Additionally, by recognizing mussels as a new and potentially informative metric, methods for evaluating stream ecosystem health will be improved.

3.11 Aquatic Plants

Invasive plants have become common or abundant in several reservoirs, and their influence on the aquatic community is largely unknown. Backwater studies conducted in the John Day Reservoir during the 1970s and early 1980s did not note the presence of water milfoil, although it is now well established in many shallow-water areas of the Columbia Gorge. Barfoot et al. (In press) observed a significant shift in the composition of the nearshore fish community over a 10-year period (1984-1995) in John Day Reservoir, possibly related to reservoir aging and increased abundance of milfoil. A recent survey (2001) of milfoil in Bonneville reservoir showed high densities along both the Oregon and Washington shores (T. Counihan, USGS, unpublished data). Aquatic plants such as milfoil often provide a protective habitat for the early life history stages of predators such as smallmouth bass or yellow perch. Little is known of the fish that currently inhabit the extensive milfoil patches in Bonneville Reservoir.

3.12 Limiting Factors Analyses

3.12.1 White Sturgeon

Table 14 lists potential factors by life history stage that could limit production in the Columbia Gorge subbasin.

All Stages

Recruitment to the population is thought to be the key factor controlling the abundance and population structure of white sturgeon populations. Therefore, we list recruitment to the egg/larval stages as a primary limiting factor for all life stages. Impacts of predation on white sturgeon at various life stages are poorly understood. Large white sturgeon (>3-4 years old) are probably not vulnerable to predation except to humans, or possibly larger sturgeon. Other large predators that prey upon sturgeon in other areas, such as marine mammals, are not present in Bonneville Reservoir. Ecological interactions between sturgeon of various life stages and other species are poorly understood, making it difficult to identify limiting factors in this area. Connectivity and passage issues are likely limiting factors for nearly all life stages of white sturgeon. Historically, white sturgeon were able to access much more of the Columbia River basin. Fragmentation by hydropower development has limited this movement, because white sturgeon do not utilize fish ladders at Columbia River dams. This limits the ability of white sturgeon to spread out to access seasonal food resources, distribute individuals from areas of high densities or poor resources, or to seek out good spawning or rearing areas. The impacts of contaminants on white sturgeon populations are relatively poorly understood. Negative impacts may include reduced spawning success and reduced growth, as well as direct or delayed mortality. Harvest by sport and commercial fisheries are limiting factors for all life stages to the extent that they impact the available abundance of spawning size fish, which produce subsequent generations. Direct impacts of harvest are limited to a narrow size range of fish (42-60" total length). Harvest guidelines are set to ensure adequate escapement of harvestable-size fish to broodstock.

Egg/Larvae

Survival of white sturgeon eggs may be limited by a number of factors including water temperature, sedimentation, and predation. Water temperatures above 17-20 C begin to negatively impact development of white sturgeon eggs. Optimum temperatures are between 11-17 C. Suspended sediments and various acids and chemicals may reduce the adhesiveness of newly fertilized eggs. This adhesiveness allows the eggs to attach to the river bottom in areas of relatively high water velocities needed for spawning and oxygenation of developing eggs. Predation experiments by the USGS indicated that predation on white sturgeon larvae by predator fish species was negatively correlated to levels of suspended sediments; indicating that higher turbidities may make it more difficult for predators to capture white sturgeon larvae. Predation on white sturgeon eggs is reported. Loss of prey base is probably not a limiting factor to this life stage since larval white sturgeon prey upon relatively abundant zooplankton, although little is known about larval white sturgeon feeding behavior.

Young-of-Year

Coutant (2004) suggested that abundance of YOY white sturgeon may be more dependent on survival of eggs and larvae than by the success of spawning events, which have heretofore received more attention. This would suggest that not only do river flows and habitats need to be managed to improve spawning conditions, but that research be directed to identify and address factors limiting survival from the egg/larval stage to YOY. There is some evidence from predation studies conducted by USGS that YOY white sturgeon are vulnerable to fish predators found in the reservoirs. They are also vulnerable to predation by other sturgeon.

Reproductive Adult

Limiting factors at this life stage include harvest, which impacts the abundance of sturgeon surviving through the harvestable size classes. Contaminants may impact survival, growth, and reproductive potential of spawners. Catch-and-release fisheries may impact this life stage via delayed mortality from handling stress or if handling stress negatively impacts reproductive potential or gamete maturity. Because of the value of caviar and sturgeon flesh, illegal harvest is a potential limiting factor for large sturgeon. Little information is available about the extent or existence of illegal harvest from Bonneville Reservoir.

3.12.2 Chum Salmon

Land development for urban, industrial, and agricultural uses near and on low gradient streams and rivers where naturally produced chum salmon occurred has undoubtedly impacted the productive potential of historic spawning, incubation, and freshwater rearing areas of chum salmon. Upland land uses such as forestry and agriculture can contribute to the sedimentation of spawning gravels in low gradient reaches. Physical blockages caused by culverts, tidegates, and warm water can limit access to spawning habitat. In the Columbia River Gorge, the construction of Bonneville and The Dalles dams and resulting impoundments of the Columbia River have inundated potential mainstem spawning and rearing areas in the mainstem as well as the lower reaches of tributaries.

Factors that limit production of chum salmon in the Columbia River Gorge are not explicitly known. Assuming that historical populations of chum salmon upstream of Bonneville Dam experienced the same stressors in the lower river, estuary, and ocean, as the populations downstream of Bonneville Dam, factors that could limit chum salmon production in the Columbia River Gorge include:

- Loss of habitat through inundation by Bonneville Dam.
- Lower propensity to ascend the fishways at Bonneville Dam compared to other anadromous species.
- Blockage to tributary habitats created by the transportation corridors or hatchery weirs.
- Sedimentation of spawning and rearing habitats in tributaries and nearshore areas of the mainstem.
- Intermittent dewatering of spawning gravels caused by operation of the FCRPS.
- Land use development along low gradient streams.
- Decreased rate of recruitment of large woody debris to lower reaches of tributaries and nearshore areas of the mainstem.
- Changes to seasonal and longer term recruitment of coarse sediments (spawning gravels) from operation of the FCRPS and tributary dams (Condit and Powerdale dams).

3.12.3 Pacific Lamprey

Without better knowledge of the distribution and duration of residency at different life stages, describing explicit factors in Bonneville Reservoir that limit the production of Pacific lamprey is difficult. Out-of-basin factors impacting Pacific lamprey are present at Bonneville and The Dalles dams, where passage measures developed for salmonids do not necessarily provide optimum benefits to migrating juvenile and adult lampreys.

If adults overwinter in the reservoir, holding conditions are assumed to be adequate in terms of availability of boulder habitat, and water temperature and quality. The availability of fine sediments is extensive in the reservoir. However, the frequent pool elevation fluctuations are likely to negatively impact the ability of juveniles to use nearshore substrates for sustained periods. Juveniles are likely to be susceptible to contaminants because they rear in fine substrates for prolonged periods. Catastrophic events such as chemical spills have the potential to impact lampreys more greatly than other fishes, because multiple year classes coexist in freshwater habitats, and die offs can contribute greatly to population instability.

Limited knowledge of population dynamics hinders fish and wildlife managers' ability to manage the species. Whether Pacific lampreys have a stock or population structure is largely unknown, and setting numerical objectives for monitoring population health is difficult. Understanding the potential to restore lamprey to streams where they have been extirpated is still a topic of investigation.

3.12.4 Bald Eagle

Generally, factors that can limit production of bald eagles include human-related killing, poisoning, habitat destruction and alteration, changes to prey base, and disturbance by humans (Stahlmaster 1987). Table 18 lists potential factors by life history stage that could limit production in the Columbia Gorge subbasin. Based on the fact that the number of bald eagles appears to be increasing in the Columbia Gorge subbasin, working hypotheses (assumptions) used to suggest potential limiting factors include:

- Contaminants in fish and waterfowl eaten by bald eagles appear to be low enough so reproductive potential of mature birds persists.
- Purposeful (illegal) killing of birds if it still exists, is presently low enough so survivorship of mature birds is adequate to sustain existing population levels in the Columbia Gorge subbasin.
- Availability of forage appears to be adequate to sustain existing population levels in the Columbia Gorge subbasin.
- Availability of perching, roosting, and nesting sites appears to be adequate to support existing population levels.
- Perching, roosting, and nesting habitat closest to water (including islands) represents optimum habitat.

Unknown limiting factors not addressed in this draft assessment include the carrying capacity of foraging, perching, roosting, and breeding territory habitat. The relative contributions of changes in region-wide distribution and local recruitment to maturity on the apparent increase in population growth rate are unknown.

3.12.5 Western Pond Turtle

Natural Factors

The western pond turtle has a long life span, requires 10 or more years to reach reproductive age, and has a low rate of recruitment. The vagaries of Pacific Northwest weather probably result in high variation in hatching success. The combination of these factors makes this species especially sensitive to any increase in chronic sources of mortality or other factors that affect reproduction and recruitment. Even relatively minor reductions in recruitment can affect the long term viability of a population, but due to the long life span of this species, changes of this nature may not be immediately evident. Turtles may persist in an area for extended periods even after the population is no longer successfully reproducing.

Habitat Loss and Degradation

Human population increases and concomitant development will continue to alter or eliminate habitat for nesting, increase the rate of predation on nesting females, nests, or hatchlings, and/or expose hatchlings to hazardous post-hatching conditions. Alteration of aquatic habitats, by water diversion projects or similar situations, may impose considerable hazard and hardship on moving turtles and result in higher than normal levels of mortality. Overland movements by western pond turtles increase their vulnerability to predators and other mortality sources. Vehicular traffic on roads that traverse western pond turtle habitat may be an important mortality factor.

Interspecific Relationships

Introduced species have changed the ecological environment in the region for pond turtles. As significant predators on hatchling and small juvenile western pond turtles, non-native species such as bullfrogs and warm water fish seem to reduce survivorship and alter recruitment patterns.

Sunfish compete for invertebrate prey. Carp muddy previously clear waters (Lampman 1946). This can influence the densities of zooplankton that can be important in the diet of hatchlings and young turtles (see Holland 1985). Carp alter aquatic habitat when feeding on submerged and emergent vegetation. Introduced turtles, such as sliders and snapping turtles may compete with pond turtles and expose them to diseases for which pond turtles have no resistance.

Disturbance

The western pond turtle appears to be relatively sensitive to disturbance. Disturbance may affect the frequency and duration of basking or foraging behavior, which may be particularly important for gravid females. Interruption of basking may lead to a delay in the maturation and deposition of eggs, leading to a decrease in hatching success or overwinter survival (Holland 1991c). Boat traffic and fishing may influence western pond turtle behavior or cause direct mortality.

Chemicals and Contaminants

The effect of biocontaminants on western pond turtles is largely unstudied. The 1993 Yonella Creek diesel spill in Oregon had negative effects on invertebrate food, habitat and health of western pond turtles. All 30 turtles recovered after the Yonella Creek diesel spill exhibited debilitating conditions that appeared to be the result of exposure to diesel fuel (USFWS 1993). Given the long lifespan of turtles and their position as a tertiary consumer in the food chain, they may act as bio-accumulators of certain contaminants such as PCBs and heavy metals, a situation known to occur in other turtle species.

4 Inventory of Existing Activities

4.1 Existing Legal Protection

Summary of Existing Legal Protections

Federal	Endangered Species Act
	Clean Water Act
	Fish and Wildlife Coordination Act
	Magnuson-Stevens Fishery Conservation and Management Act
	Migratory Bird Treaty Act
	Northwest Forest Plan
	Columbia River Gorge National Scenic Area Act
	Rivers and Harbors Act
	Bald Eagle Protection Act
State (Oregon/Washington)	Oregon Forest Practices Act
	Washington Forest Practices Act
	Oregon Removal-Fill Law
	Fishing and Harvest Regulations
	Washington Growth Management Act
	Washington Shoreline Management Act
	Washington Bald Eagle Habitat Buffer Rule
	Washington Fish and Wildlife Commission 1986 Bald Eagle Habitat Protection Rule
Local	Hood River County Zoning Ordinance
	Wasco County Land Use and Development Ordinance
	Skamania County Zoning Ordinances
	Klickitat County Zoning Ordinances
	Washington Critical Area Ordinances

4.1.1 Federal

Endangered Species Act – The 1973 Endangered Species Act provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered in the U.S. or elsewhere. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions. The Endangered Species Act also is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora, commonly known as CITES. Criminal and civil penalties are provided for violations of the Act and the Convention.

Clean Water Act - The Clean Water Act established the basic structure for regulating discharges of pollutants into the waters of the United States. It gave the Environmental Protection Agency the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act also continued requirements to set water quality standards for all contaminants in surface waters. The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. It also funded the construction of sewage treatment plants under the construction grants program and recognized the need for planning to address the critical problems posed by nonpoint source pollution.

Section 404 of the Act regulates the discharge of dredged or fill material into all waters of the United States, including wetlands, both adjacent and isolated. The USACE presides over permitting, mitigation, and enforcement of Section 404.

Fish and Wildlife Coordination Act - The Act provides that whenever the waters or channel of a body of water are modified by a department or agency of the U.S., the department or agency first shall consult with the U.S. Fish and Wildlife Service and with the head of the agency exercising administration over the wildlife resources of the state where construction will occur, with a view to the conservation of wildlife resources. The Act provides that land, water and interests may be acquired by federal construction agencies for wildlife conservation and development. In addition, real property under jurisdiction or control of a federal agency and no longer required by that agency can be utilized for wildlife conservation by the state agency exercising administration over wildlife resources upon that property.

Magnuson-Stevens Fishery Conservation and Management Act – The U.S. Congress passed the Magnuson-Stevens Fishery Conservation and Management Act in 1976. It created a 200-mile limit of U.S. control over waters once heavily fished by foreign fleets. It also set up a federal management system for fishing between three and 200 nautical miles. States continue to manage fishing out to three miles but now they must coordinate what they do with federal management. The Sustainable Fisheries Act amended the Magnuson-Stevens Act in 1996. The Sustainable Fisheries Act is a landmark piece of legislation containing strict new mandates to stop overfishing, rebuild all overfished stocks, minimize bycatch, and protect essential fish habitat.

The Magnuson Act involves power-sharing arrangements between regional management councils and the U.S. Department of Commerce. The councils write and revise fishery management plans (FMPs) and also make decisions as required by those FMPs. NOAA Fisheries provides scientific advice and reviews the plans to make sure that they meet the legal obligations of the Act. The Department of Commerce has the final say on plan approval.

Approved plans are implemented by NOAA Fisheries and enforced by the U.S. Coast Guard. Congress oversees the process by regular reauthorization of the Magnuson Act and designating funding for the Councils, NOAA Fisheries, and the Coast Guard.

Migratory Bird Treaty Act - The Migratory Bird Treaty Act implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing or possessing migratory birds is unlawful.

Northwest Forest Plan - Federal forest lands west of the Cascade Range in Washington and Oregon are governed by the Northwest Forest Plan, which was developed following the Presidential Forest Summit of 1993. The Northwest Forest Plan has three parts: a program for managing the forests to achieve both sustainable timber production and protection of biological diversity; a system for coordinating federal agency implementation of the forest management effort and receiving advice from non-federal interests; and an initiative for providing economic assistance and job retraining to displaced timber workers, communities, and others who were adversely affected by reductions in the size of the timber program.

Columbia River Gorge National Scenic Area - The Columbia River Gorge National Scenic Area was created on November 17, 1986 when President Reagan signed into effect Public Law 99-663. One of the purposes of the Act is to protect and enhance natural resources including fish and wildlife. The entire Columbia Gorge Subbasin is within the Scenic Area and proposed land use is subject to review by the Forest Service to ensure consistency with the Scenic Area Management Plan.

Rivers and Harbors Act – Section 10 of the Rivers and Harbors Act requires authorization for the construction of any structure in or over any navigable water of the United States. This law applies to any dredging or disposal of dredged materials, excavation, filling, rechannelization, or any other modification of navigable water of the United States, and applies to all structures. The USACE presides over permitting, mitigation, and enforcement of Sections 10 and 13 of the Act.

Bald Eagle Protection Act - Prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions.

4.1.2 State

Oregon Forest Practices Act - The Oregon Department of Forestry enforces the Oregon Forest Practices Act (OAR 629-Division 600 to 680 and ORS 527) regulating commercial timber production and harvest on state and private lands. The Act contains guidelines to protect forests and streams in forest management activities including road maintenance, road construction, chemical application, slash burning, timber harvest, and reforestation.

Washington Forest Practices Act – The Forest Practices Act defines a plan to protect public resources while assuring that Washington continues to be a productive timber growing area. The Act regulates activities related to growing, harvesting, or processing timber on all local government, state, and private forestlands. The Act provides for a riparian space program that includes acquisition and conservation easement on lands within unconfined avulsing channel migration zones.

Oregon Removal-Fill Law - Oregon Division of State Lands, under Removal-Fill Law (ORS 196.795-990) and the U.S. Army Corps of Engineers, under Section 404 of the Clean Water Act, regulate the removal and filling of materials in wetlands and waterways. Under state law, permits are required for projects involving 50 or more cubic yards of material in wetlands and streams. Permit applications are reviewed by ODFW and may be modified or denied based on project impacts to fish. Projects that may affect ESA-listed species require consultation with NOAA Fisheries or the U.S. Fish and Wildlife Service to insure compliance with the Endangered Species Act. The Oregon Removal-Fill Law requires a permit for most removal and fill activities in areas designated by the state as essential indigenous salmonid habitat. Essential salmonid habitat is defined as the habitat necessary to prevent the depletion of native salmon and trout species during their life history stages of spawning and rearing. The designation applies to species listed as Sensitive, Threatened or Endangered by a state or federal authority.

Fishing and Harvest Regulations – Commercial fishing seasons in the mainstem Columbia River (concurrent jurisdictional waters) are established by the Columbia River Compact while Select Area commercial fishing seasons occurring in state waters are established by the regulating state. The Columbia treaty tribes regulate treaty Indian Ceremonial and Subsistence fisheries in the mainstem Columbia and tributaries. Recreational fishing regulations for the Columbia River are established separately by the management agencies of Washington and Oregon. Recreational regulations set by each state in the concurrent Columbia River waters are usually identical. All fisheries of the Columbia River are established within the guidelines and constraints of the Columbia River Fish Management Plan (CRFMP), the Endangered Species Act (ESA), and management agreements negotiated between the Parties to U.S. v. Oregon. The Columbia River Inter-Tribal Fisheries Enforcement (CRITFE) monitors tribal fisheries and enforces fishing regulations in the Columbia River between Bonneville and McNary Dams, including closures around the mouth of the Hood River.

Washington Growth Management Act – The Growth Management Act requires cities and counties to plan for growth and development through a comprehensive, coordinated, and proactive land use planning approach. The Act is adopted and implemented at the local government level.

Washington Shoreline Management Act - Provides for some tree retention within 61 m (200 ft) of the shorelines of rivers and marine waters.

Washington Bald Eagle Habitat Buffer Rule - State Legislature's 1984 RCW 77.12.655: Habitat buffer zones for bald eagles.

Washington Fish and Wildlife Commission 1986 Bald Eagle Habitat Protection Rule - (WAC 232-12-292) provides for development of a Site Management Plan whenever activities that alter habitat are proposed near a verified nest territory or communal roost.

4.1.3 Local

Hood River County Zoning Ordinance - The Zoning Ordinance implements policies of the County Comprehensive Land Use Plan (amended March 2004) that identifies areas zoned as forest land and where protection articles apply. Zoning especially relevant to fish and wildlife includes:

a) Article 35- Natural Area Zone (NA) is designed to protect identified natural areas by allowing only uses that will not adversely impact or destroy the Natural Area. Timber, mining, and farm uses including buildings are permitted conditional uses subject to approval criteria.

b) Article 44 – Floodplain Zone (FP) is for the protection of life and property from natural disasters and hazards. Key section is Section 44.55 (C) Water Course Setbacks, which states that all buildings shall be set back 100 feet from the ordinary high water line except for water-dependent uses.

c) Article 43 – Environmental Protection Zone (EP) is for protection and maintenance of soil stability, water quality, watersheds, natural drainage areas, fish and wildlife habitat, and natural areas. Low intensity recreation, agriculture, and irrigation water uses are allowed, as are utilities and road crossings provided floodplain alteration does not occur or compliance with Article 44 is met. Other development may be allowed if a finding is made that the proposal complies with conditions including approval by a registered engineer, geologist or architect.

d) Article 45 – Geologic Hazard Zone (GH) identifies existing or potential geological hazards and related precautions or development restrictions.

e) Article 75 - National Scenic Area Ordinance has additional requirements for protection of wetlands, streams, and natural areas.

f) Article 42- Stream Protection Overlay Zone became effective in March 2004 with passage of Ordinance No. 253. The article regulates land use within a 50-foot buffer zone along all fish bearing streams except the Hood River, where 75-foot buffers apply. Native vegetation removal is prohibited in the buffer with certain exceptions. Activities on farm or forest zoned lands regulated by the Forest Practices Act are exempt, as are agricultural activities regulated under State Senate Bill 1010. Activities along fishless streams were not addressed. The article helps meet county obligations under the DEQ Hood Basin TMDL and the Statewide Planning Goal 5 for Natural Resources.

Wasco County Land Use and Development Ordinance - This Ordinance was enacted to regulate and restrict the location and use of buildings, structures, and land for residence, trade, industry, and other land use activities; to regulate and limit the height, number of stories, and size of buildings and other structures hereafter erected or altered; to regulate and limit the density of population and to divide Wasco County into districts or zones of such number, shape and area as may be deemed best to carry out these regulations and to provide for the enforcement of these regulations.

Section 3.700 of the Ordinance created an Environmental Protection District, whose function is partially to permit the (1) regulation of environmental hazards, (2) qualification of lands for floodplain insurance programs and preferential taxation assessment, (3) preservation of sensitive wildlife habitats and unique areas of scientific or aesthetic value, and (4) the protection of the health, safety and welfare of residents of Wasco County.

Skamania County Zoning– Skamania County zoning is guided by Ordinance 1985-05 § 1.0.1

http://www.skamaniacounty.org/bpc/html/maintoc.htm .

Klickitat County Zoning- Klickitat County zoning is guided by Ordinance No. 62678, which includes the Klickitat County Shoreline Master Plan and the Flood Plain Management Ordinance

http://www.klickitatcounty.org/Planning

Washington Critical Area Ordinances – As part of the Growth Management Act, cities and counties are required to adopt policies and regulations that protect critical areas, such as fish and wildlife habitat conservation areas, wetlands, frequently flooded areas, aquifer recharge areas, and geologically hazardous areas.

4.2 Existing Plans

Summary of Existing Management Plans

Tribal	Wy-Kan-Ush-Mi Wa-Kish-Wit
Federal	Mt. Hood National Forest Land and Resource Management Plan
	Gifford Pinchot National Forest Plan
	Columbia Gorge Scenic Area Management Plan
	Endangered Species Act Implementation Plan for the FCRPS
	FCRPS Biological Opinion and the Basinwide Salmon Recovery Strategy
	Columbia River Fish Management Plan
	U.S. Fish and Wildlife Service 1986 Pacific States Bald Eagle Recovery Plan
State (Oregon/Washington)	Oregon Plan for Salmon and Watersheds
	Washington Statewide Strategy to Recover Salmon
	Washington Department of Fish & Wildlife's Priority Habitat and Species Management Recommendations, Volume IV: Birds.
	Western Pond Turtle Recovery Plan
Local	Hood River County Comprehensive Land Use Plan
	Wasco County SWCD Strategic Plan
	Klickitat County Shoreline Master Plan

4.2.1 Tribal Plans

Wy-Kan-Ush-Mi Wa-Kish-Wit - This is the Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes (CRITFC 1996). This plan includes adult return targets for each subbasin in the Columbia Basin. Wy-Kan-Ush-Mi Wa-Kish-Wit recommends habitat restoration actions that focus on limiting, restricting, or eliminating land uses and enhancing populations with implementation of new broodstock, release and production programs. The plan was published in 1996, and habitat restoration projects emphasizing implementation of forest, range, and agricultural best management practices have been initiated in priority watersheds since 1997 through the Council's program.

4.2.2 Federal Plans

Mt. Hood National Forest Land and Resource Management Plan - The U.S. Forest Service (USFS) manages the Columbia River Gorge National Scenic Area. Management of these lands is guided by USFS policies and federal legislation. Management guidelines for the subbasin are contained in the Mt. Hood National Forest Land and Resource Management Plan and Attachment A: Standards and Guidelines for Management of Habitat for Late Successional and

Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl of the 1994 Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (Northwest Forest Management Plan). These plans provide standards and guidelines for management of the national forest lands in the subbasin. Included in the Northwest Forest Management Plan is the Aquatic Conservation Strategy (ACS), which was developed to maintain and restore the ecological health of watersheds and aquatic ecosystems on public lands. The four components of the ACS, riparian reserves, key watersheds, watershed analysis, and watershed restoration are designed to operate together to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems. The ACS provides protection of salmon and steelhead habitat on federal lands by striving to maintain and restore ecosystem health at watershed and landscape scales to protect habitat for fish and other riparian-dependent species and resources, and restore currently degraded habitats. This approach seeks to prevent further degradation and restore habitat over broad landscapes.

Gifford Pinchot National Forest Plan - In 1990, the Gifford Pinchot National Forest published its first Land and Resource Management Plan (Forest Plan) developed under the NFMA and the National Environmental Policy Act (NEPA). The Forest has made several amendments since 1990.

Columbia Gorge Scenic Area Management Plan - All of the Columbia Gorge subbasin is in the Scenic Area boundary. The Federal Act establishing the Columbia River Gorge National Scenic Area mandated that each county within the Scenic Area either adopt regulations to implement the Management Plan for their portions of the Scenic Area or relinquish control of land development within the Scenic Area to the Columbia River Gorge Commission. The Columbia River Gorge National Scenic Area Management Plan (Columbia River Gorge Commission and USDA Forest Service, 1992) is implemented by the USFS and the Columbia Gorge Commission to insure that land use is consistent with the Scenic Area Act. In the Columbia Gorge Subbasin, the Scenic Area Management Plan is implemented primarily by Hood River, Wasco, Skamania, and Klickitat counties, with oversight by the Columbia Gorge Commission.

Endangered Species Act Implementation Plan for the FCRPS - The three action agencies have prepared the implementation plan in acknowledgement of responsibilities for fish protection under the Northwest Power Act and water quality protection under the Clean Water Act, and their obligations to Indian tribes under law, treaty, and Executive Order. The plan responds to the December 2000 Biological Opinions issued by the U.S. Fish and Wildlife Service and the NOAA Fisheries on the effects to listed species from operations of the Columbia River hydropower system. The plan is a five-year blueprint that organizes collective fish recovery actions by the three agencies. The plan looks at the full cycle of the fish, also known as "gravel to gravel" management or an "All-H" approach (hydro, habitat, hatcheries, and harvest). However, it describes only commitments connected to the FCRPS, not the obligations of other federal agencies, states, or private parties. The plan describes the three agencies' goals; the performance standards to gauge results over time; strategies and priorities for each H; detailed five-year action tables for each H; research, monitoring, and evaluation plan (RM&E); and expectations for regional coordination.

FCRPS Biological Opinion and the Basinwide Salmon Recovery Strategy - NOAA Fisheries has recently developed several documents and initiatives for the recovery of Endangered Species Act listed Snake River steelhead, chinook and sockeye. The Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) and the Basinwide Salmon Recovery Strategy issued at the end of 2000 contain actions and strategies for habitat restoration and protection for the Columbia River Basin. Action agencies are identified that will lead fast-start efforts in specific aspects of restoration on nonfederal lands. Federal land management will be implemented by current programs that protect important aquatic habitats (PACFISH, ICBEMP). Actions within the FCRPS BiOp are intended to be consistent with or complement the Council's amended Fish and Wildlife Program and state and local watershed planning efforts.

NOAA Fisheries has also initiated recovery planning with the establishment of a Technical Recovery Team for the Interior Columbia, which includes Snake River stocks. The Technical Recovery Team will identify delisting criteria and viability criteria for populations within ESUs, identify factors that limit recovery, and identify early actions for recovery among other things. A stakeholder-based forum will develop a formal recovery plan from these products.

For federally listed resident species (bull trout in the Columbia Gorge mainstem subbasin) impacted by the FCRPS , USFWS is working with State and Tribal agencies to develop the Draft Bull Trout Recovery Plan. The goal of the recovery plan is describe actions needed to achieve the recovery of bull trout and ensure their long term persistence. Specific recovery objectives include maintaining or increasing the present distribution within core areas; maintaining stable or increasing trends in abundance; restoring and maintaining habitat conditions that are suitable for bull trout across all life history stages and strategies; and conserving genetic diversity and providing opportunity for genetic exchange.

Under the 2000 FCRPS BiOp, NOAA Fisheries expects the Bonneville Power Administration, the Corps of Engineers, and the Bureau of Reclamation to meet their ESA obligations in part through offsite mitigation. Subbasin plans will become local recovery plans or will become a substantial component of NOAA Fisheries recovery planning. The BiOp relies on subbasin plans to identify and prioritize specific actions needed to recover listed salmon and steelhead in tributary habitats. NOAA Fisheries expects subbasin plans to include implementation of the BiOp's offsite mitigation actions in the Reasonable and Prudent Alternative (RPA). Specifically, subbasin planning should provide for RPA habitat actions 149 through 163 and harvest and hatchery RPA actions 164 through 178 that pertain to and require local planning and management. NOAA Fisheries also expects subbasin plans to incorporate the research, monitoring, and effective strategies and actions, particularly those described in RPA action 179, 180, and 183.

Columbia River Fish Management Plan - The Columbia River Fish Management Plan (CRFMP) is an agreement resulting from the U.S. District Court case of U.S. V. Oregon (Case No. 68-513). This agreement between federal agencies, Indian tribes and state agencies (except Idaho) set guidelines for the management, harvest, hatchery production, and rebuilding of Columbia River Basin salmonid stocks. Appropriate harvest levels and methods were established for various levels of attainment of interim population goals for spring chinook, summer chinook, sockeye, fall chinook, summer steelhead, and coho salmon. The plan guaranteed the treaty Indian fisheries a minimum of 10,000 spring and summer chinook annually, not dependent on run size.

U.S. Fish and Wildlife Service 1986 Pacific States Bald Eagle Recovery Plan

4.2.3 State Plans

Oregon Plan for Salmon and Watersheds - Approved by the Oregon legislature in 1997, Oregon Plan for Salmon and Watersheds and the 1998 Steelhead Supplement outlines a statewide approach to ESA concerns based on watershed restoration, ecosystem management, coordination among state agencies, and local solutions to protect and improve salmon and steelhead habitat. The Oregon Watershed Enhancement Board provides grant funds and technical support for watershed groups and others to help implement the Oregon Plan locally.

Washington Statewide Strategy to Recover Salmon – Created by the Washington Governor's Salmon Recovery Office and Joint Natural Resources Cabinet, this plan describes how Washington's state agencies and local governments can work together to address habitat, harvest, hatcheries, and hydropower issues as they relate to recovery of listed species.

Washington Department of Fish & Wildlife's Priority Habitat and Species Management Recommendations, Volume IV: Birds

Western Pond Turtle Recovery Plan - The recovery plan identifies WDFW recovery goals for three populations of western pond turtle in the Bonneville Pool. Each of the three populations must reach at least 200 animals and meet conservation targets for age structure, reproduction, and habitat security.

4.2.4 Other Plans

Hood River County Comprehensive Land Use Plan - Amended in March 2004, the Comprehensive Plan guides land use on private and County-owned lands in accordance with statewide goals and requirements, with oversight from the Land Conservation and Development Commission. The Hood River County Comprehensive Plan consists of the: 1) County Policy Document; 2) County Comprehensive Plan Map; 3) Zoning Map, and Zoning and Subdivision Ordinances; 4) Background Reports; and 5) Exceptions Document. Pertinent policy goals are to a) Conserve open space and protect natural and scenic resources, b) Conserve and/or preserve fish, wildlife, and their habitat areas, and c) Insure protection and provision of adequate habitat for wildlife species native to the area.

Wasco County SWCD Strategic Plan - Wasco County SWCD adopts a strategic plan on a five-year basis. The strategic plan describes the goals and objectives of the SWCD during that five-year period. Every year, the SWCD adopts an annual plan of work that specifies actions and responsibilities for that year.

4.3 Existing Management Programs

Summary of Existing Management Programs

Tribal	Confederated Tribes of the Umatilla Indian Nation
	Confederated Tribes of the Warm Springs Reservation of Oregon
	Nez Perce Tribe
	Yakama Indian Nation
	Columbia River Inter-Tribal Fish Commission
Federal	National Oceanic Atmospheric Administration Fisheries
	U.S. Fish and Wildlife Service
	U. S. Environmental Protection Agency
	U.S. Army Corps of Engineers
	Northwest Power and Conservation Council
State (Oregon/Washington)	Oregon Department of Environmental Quality
	Washington Department of Ecology
	Oregon Department of Fish and Wildlife
	Washington Department of Fish and Wildlife
	Oregon Department of Forestry
	Oregon Department of Transportation
	Washington Department of Transportation
	Oregon Division of State Lands
	Washington Department of Natural Resources
	Washington State Department of Agriculture
	Enforcement of Hunting and Fishing Regulations
	Land Conservation and Development Commission
Local	Hood River County Noxious Weed Control Program
	Hood River County Planning Department
	Wasco County Planning Department
	Wasco County Soil and Water Conservation District
	Skamania County Planning Commission
	Klickitat County Planning Department
	Klickitat County Shoreline Master Plan

4.3.1 Tribal Programs

The Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian Nation are the only tribes in the Columbia Basin to have reserved rights to anadromous fish in 1855 treaties with the United States. Each of the four tribes is a co-manager of state fisheries resources along with Oregon Department of Fish and Wildlife and the Washington Department of Fish and Wildlife. The Four Tribes coordinate participation in fisheries management through the Columbia River Inter-Tribal Fish Commission.

4.3.2 Federal Programs

National Oceanic Atmospheric Administration Fisheries - The National Oceanic Atmospheric Administration (NOAA) Fisheries administers the federal Endangered Species Act as it pertains to anadromous fish. NOAA Fisheries reviews and comments on fill/removal permit applications on streams with anadromous salmonids and on any hydroelectric project proceedings where anadromous fish are involved.

U.S. Fish and Wildlife Service - The U.S. Fish and Wildlife Service is the principal Federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people. The Service manages the National Wildlife Refuge System, National Fish Hatchery System, fishery resource offices, and ecological services field stations. The Service enforces Federal wildlife laws, administers the Endangered species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their conservation efforts. It also oversees the Federal Aid program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies.

The U. S. Fish and Wildlife Service also implements the Environmental Contaminants Program, which applies to all watersheds within the Columbia River Basin. The Environmental Contaminants program conducts studies that help reveal the health of terrestrial and aquatic ecosystems. Wildlife and fish populations are assessed for the health of their habitats, populations and individual organisms. The purpose is to identify and prevent the harmful effects of contaminants on fish and wildlife, and to restore resources degraded by contamination.

U. S. Environmental Protection Agency - The mission of the Environmental Protection Agency is to protect human health and the environment. Primary EPA activities include developing and enforcing regulations, performing environmental research, and further environmental education.

U.S. Army Corps of Engineers - The U.S. Army Corps of Engineers operates and maintains Bonneville and The Dalles locks and dams for hydropower production, fish and wildlife protection, recreation and navigation. The USACE is the lead agency for operation of fishways and monitoring fish passage.

Northwest Power and Conservation Council - The Northwest Power and Conservation Council develops and maintains a regional power plan and a Columbia River Basin Fish and Wildlife Program to balance the Northwest's environment and energy needs. The Council is responsible for developing a 20-year electric power plan that guarantees adequate and reliable energy at the lowest economic and environmental cost to the Northwest, developing a program to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River Basin, and educating and involving the public in the Council's decision-making process. The Council works to protect, mitigate, and enhance fish and wildlife of the Columbia River and guides Bonneville Power Administration's funding of projects to implement the Fish and Wildlife program.

4.3.3 State Programs

Oregon Department of Environmental Quality - The Oregon Department of Environmental Quality (ODEQ) is required by the *Federal Clean Water Act* to establish water quality standards to protect the beneficial uses of the State's waters. Based on the water quality standards, ODEQ is then required to: identify stream segments where the standards are not being met; develop a list of these water-quality limited water bodies (called the 303(d) list from Section 303(d) of the Clean Water Act); and develop a Total Maximum Daily Load (TMDL) allocation for each water body included on the 303(d) lists. The TMDL describes the maximum amount of pollutants (from all sources) that may enter a specific water body without violating water quality standards.

The Department of Environmental Quality administers the EPA 319 Non-Point Source (319) Program in the State of Oregon. The 319 Program provides up to 60% cost-share for projects targeting nonpoint source water pollution issues. 319 funds are for implementation activities, including monitoring used to support TMDL development, implementation and measuring progress toward achieving TMDL allocations.

Washington Department of Ecology - Washington's principal environmental management agency. Their mission is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations. Department goals are to prevent pollution, clean up pollution, and support sustainable communities and natural resources.

Oregon Department of Fish and Wildlife - Oregon Department of Fish and Wildlife (ODFW) is responsible for protecting and enhancing Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations. Management of the fish and wildlife and their habitats in the Columbia Gorge subbasin is guided by ODFW policies and federal and state legislation. ODFW policies and plans that pertain to the subbasin include the Natural Production Policy (OAR 635-07-521 to 524), The Native Fish Conservation Policy (635-007-0502 to 0505), and Oregon Guidelines for Timing In-Water Work to Protect Fish and Wildlife Resources. These plans present systematic approaches to conserving aquatic resources and establishing management priorities within the subbasin.

Washington Department of Fish and Wildlife - Washington Department of Fish and Wildlife manages land for fish, wildlife, and recreation needs. The Department is mandated to preserve, protect, and perpetuate fish and wildlife and their habitat. A goal of the Department is to encourage and assist local governments in adopting policies and regulations to protect fish and wildlife habitat. The Priority Habitats and Species Program is the principal means by which the Department provides important fish, wildlife, and habitat information to local governments, state and federal agencies, private landowners and consultants, and tribal biologists for land use planning purposes. The Department also provides a partnership-based information system that characterizes freshwater and estuary habitat conditions and distribution of salmonid stocks in Washington.

Oregon Department of Forestry - The Oregon Department of Forestry regulates forest management activities on non-federal lands. The Oregon Forest Practices Act (ORS 527 and administrative rules division 629-600 through 629-680) regulates forest management activities including harvesting, road construction, slash burning, chemical application and reforestation. The rules contain a large body of water protection rules (OAR 629-635 through 629-660) based on current science that reflect the best management practices required by operators when conducting cultural practices in the forest. These guidelines include mandatory stream buffers and riparian management areas, as well as protection to small tributaries important for maintaining cool water temperature downstream.

Oregon Department of Transportation - The Oregon Department of Transportation (ODOT) maintains state highways in the Columbia Gorge subbasin. Bridges and culverts, as they are upgraded or replaced, must meet guidelines designed to protect fish and fish habitat. In particular, guidelines are specified in the 4d Rule for threatened Mid-Columbia steelhead, written by NOAA Fisheries.

Washington Department of Transportation - The Environmental Services Department of the Department of Transportation is responsible for implementation of the department's transportation services with consideration of environmental resources. The goal of the program is to ensure that fish have access to available functional habitat for spawning, rearing, and migration. The Biology Branch addresses issues involved with the Endangered Species Act, Fish Passage, Wetland Mitigation, and Wetland Monitoring. The Compliance Branch addresses regulatory compliance with the National Environmental Policy Act (NEPA) and administers the Advance Environmental Mitigation Revolving Account for watershed management. Compliance also addresses flood management and hydrogeology, stormwater management, and NPDES. The Resource Branch addresses cultural resources, hazardous materials, water quality and erosion control, and air quality.

Oregon Division of State Lands - Oregon Division of State Lands is responsible for regulating the removal and fill of materials in natural waterways. Permitted fill or removal activities are required to be consistent with instream work periods established by ODFW.

Washington Department of Natural Resources - The Department of Natural Resources manages state-owned lands for various resource uses. These include preservation, mineral extraction, commercial and industrial development, dredged material disposal, and recreational development. The Department has a Habitat Conservation Plan (HCP) in place with the U. S. Fish and Wildlife Service that incorporates restoration, protection, and maintenance of existing habitat. The Department manages the Riparian Management Zone (RMZ) under the HCP for all Washington State lands. The Department oversees 2.2 million acres of forested trust lands, which include requirements for the RMZ on certain water types affected by timber harvest activities. The goal of the Department's Aquatic Land Management Program is to restore and maintain riparian habitat on non-federal forestland, while meeting the requirements of the Clean Water Act, and supporting a harvestable supply of fish.

Washington State Department of Agriculture - The goal of the Department of Agriculture's Water Quality Protection Program is to work together with the agricultural community and regulators to protect water resources. The program addresses a variety of surface and ground water issues that involve fertilizers and pesticides. The Department is also evaluating current pesticide use practices in conjunction with pesticide residue data in surface waters that provide habitat for ESA-listed species.

Enforcement of Hunting and Fishing Regulations - Oregon State Police (OSP) and Washington Department of Fish and Wildlife enforce fishing and hunting regulations in the subbasin with special attention to ESA-listed salmonids through covert and overt patrols, and routine checks for licenses, tags, bag limits, weapon/gear type, area, season, and other regulations. Two Fish and Wildlife Law Enforcement Officers are based in Hood River, one of which is funded by the Oregon Plan for Salmon and Watersheds. The officers are part of a regional team of 7 covering a 5-county area. The Columbia River Inter-Tribal Fisheries Enforcement (CRITFE) monitors tribal fisheries and enforces fishing regulations in the Columbia River between Bonneville and McNary Dams.

Land Conservation and Development Commission - The Land Conservation and Development Commission regulates land use on the state level in Oregon. County land-use plans must comply with statewide land-use goals. Land-use plans have been helpful in protecting fish habitat, particularly by curtailing excessive development along streams.

4.3.4 Local Programs

Hood River County Noxious Weed Control Program - Currently, 23 invasive plant species are targeted for control or eradication by the County Weed and Pest Department, which controls noxious weeds, combining biological controls, herbicide use and mechanical mowing or removal. Hood River County serves as a coordinating agency and contracts with BPA, State Parks, Oregon Department of Transportation, and the U.S. Forest Service to control noxious weeds in the subbasin.

Hood River County Zoning Ordinance - The *Hood River County Comprehensive Land Use Plan* (Hood River County Planning Department, amended February 21, 1984) identifies areas where a number of Environmental Protection ordinances apply. Zoning ordinances with a major influence on fish and wildlife include the following:

- ✓ Natural Area Zone (NA) is designed to protect identified natural areas by allowing only uses that will not adversely impact or destroy the Natural Area.
- ✓ Article 44 – Floodplain Zone (FP) is for the protection of life and property from natural disasters and hazards. Key section is Section 44.55 (C) Water Course Setbacks, which states that all buildings shall be set back 100 feet from the ordinary high water line except for water-related or water-dependent uses.
- ✓ Article 43 – Environmental Protection Zone (EP) is for protection and maintenance of soil stability, overall water quality, watersheds, natural drainage areas, fish and wildlife habitat and natural areas.
- ✓ Article 45 – Geologic Hazard Zone (GH) identifies existing or potential geological hazards and related precautions or development restrictions.
- ✓ Article 75 - National Scenic Area Ordinance has additional requirements for protection of wetlands, streams, and natural areas.
- ✓ Stream Protection Overlay Zone – In a recent Statewide Planning Goal 5 Riparian Corridors Periodic Review Completion, the county updated its Natural Resources Protection standards to enact a zoning ordinance regulating new land use activities within a 50 foot buffer zone along all fish bearing streams except the Hood River below the West Fork, where 75 foot buffers apply. Removal of native riparian vegetation is prohibited inside the buffer zone, with specific exceptions. Activities regulated by the Forest Practices Act are exempt, as are agricultural activities regulated under State Senate Bill 1010.

Wasco County Planning Department - The Wasco County Planning Department regulates land use on the county level. The Wasco County Comprehensive Plan and Land Use and Development Ordinance address protection of water bodies, ground water, natural areas, agricultural land and fish and wildlife resources. The plan has helped minimize impacts to riparian corridors and big game habitat, particularly deer and elk winter range.

Wasco County Soil and Water Conservation District - Wasco County Soil and Water Conservation District (SWCD) works with farmers and ranchers to develop farm conservation plans and resource management plans. They administer grants to encourage conservation work. Wasco County SWCD has assisted the Public Works department in design modification and installation of settling basins, drop-structures, ditches, and culverts.

Skamania County Planning Commission - The Skamania County Planning Commission was formed in 1975 in order to make recommendations to the Board of County Commissioners. The Planning Commission conducts hearings on the following types of applications: Preliminary plats, final plats, zone changes, ordinance amendments and comprehensive plans. Its decisions are considered recommendations to the Board of County Commissioners. The Board of County Commissioners may approve, deny, or modify any Planning Commission recommendation

4.4 Existing and Recent Projects

Existing and recent fish and wildlife projects in the Columbia Gorge subbasin, funded in part or entirely by BPA.

Project Type	Name	Lead Entities	Years Conducted	Funding Source	Effectiveness/Outcome
White sturgeon assessment	White sturgeon mitigation and restoration in the Columbia and Snake rivers upstream from Bonneville Dam	ODFW, WDFW, CRITFC, USGS, OSU	1986-current	BPA - 198605000	
Juvenile salmonid survival	Northern Pikeminnow Management Program	PSMFC, ODFW, WDFW	1990-current	BPA - 199007700	Over 300,000 northern pikeminnow have been removed from Bonneville Reservoir since 1990. Annual exploitation rate has averaged approximately 10%, ranging from 6% to 13% since 2000. Annual exploitation rate throughout the lower Columbia River Basin has averaged about 12%, resulting in an estimated 25% reduction in predation on juvenile salmonids.
Water quality monitoring	Gas bubble disease research and monitoring of juvenile salmonids		1996-?	BPA - 199602100	

Western pond turtle restoration		WDFW, USFWS, OR Zoo, Woodland Park Zoo (Seattle)	1999-	BPA - 200102700	
Salmon spawning assessment	Evaluate spawning of fall Chinook salmon and chum salmon just below the four lowermost mainstem dams	WDFW, ODFW, USFWS	1999-current	BPA - 199900301	
Bull trout assessment	Bull trout population assessment in the Columbia River Gorge, WA.	WDFW		BPA - 199902400	Expanded from Washington tributaries to include sampling for adult bull trout in Drano Lake (mouth of Little White Salmon River). No bull trout found after limited sampling.
Cutthroat trout assessment	Evaluate Status of Coastal Cutthroat Trout in the Columbia River Basin above Bonneville Dam	USGS	2001	BPA - 2000102600	
Law Enforcement			2000-?	BPA - 200005600	

	Locate, Mark, and Removal of Lost "Ghost" Fishing Nets in Selected Columbia River Reservoirs: A Feasibility Study	CRITFC	2001	BPA - 200105800	

4.5 Gap Assessment of Existing Protections, Plans, Programs and Projects

This section evaluates gaps in projects or activities needed to address the limiting factors or threats to fish and wildlife populations identified in the assessment. The gaps were determined by evaluating the extent to which limiting factors or threats identified in the Assessment have been addressed or eliminated by the projects, legal protections, plans, and programs described in this chapter.

- ✓ **Water Quality and Contaminants –** Highly limiting factor for white sturgeon. Affects food quality of these fish for harvest. Contaminants may impact survival, growth, and reproductive potential of spawners. Existing laws and programs are in place to control current assaults on water quality, however past practices have left a legacy of contamination in the forebay of Bonneville Dam that may be limiting productivity and food quality of the fish. It is unclear if existing cleanup efforts will be able to fully alleviate past contamination and how long it will be before seeing a corresponding reduction in clam and crayfish toxicant levels.

- ✓ **Base Flow and Flow Variation –** Flow and flow variation directly affect velocity which is a spawning cue for white sturgeon, as such this may be a may be a moderately limiting factor. Still flows during the spawning period typically allow some spawning to occur in Bonneville Reservoir. In Bonneville Reservoir little white sturgeon spawning habitat is available at flows less than 125 Kcfs and high-quality habitat first becomes available at flows >150 Kcfs. While studies have been conducted and results reported, there is no formal recommendation or guideline for appropriate flows to ensure continued availability of white sturgeon spawning habitat.

- ✓ **Water Temperature –** Water temperatures may be a moderately limiting factor for white sturgeon spawning and egg development. Water temperatures above 17-20 C begin to negatively impact development of white sturgeon eggs. Optimum temperatures are between 11-17 C.

- ✓ **White Sturgeon Harvest –** If not properly monitored and regulated fishing mortality losses may be a moderate to highly limiting factor for white sturgeon. Harvest (legal and illegal) which impacts the abundance of sturgeon surviving through the harvestable size classes. Catch-and-release fisheries may impact this life stage via delayed mortality from handling stress or if handling stress negatively impacts reproductive potential or gamete maturity. Because of the value of caviar and sturgeon flesh, illegal harvest is a potential limiting factor for large sturgeon. Little information is available about the extent or existence of illegal harvest from Bonneville Reservoir.

- ✓ **White Sturgeon Connectivity and Passage Among Columbia River Reaches –** In Bonneville Reservoir this is not currently a limiting factor except that density of small fish may be limiting white sturgeon growth to some extent. However, upstream reaches do not receive upstream migrant sturgeon from Bonneville Reservoir to offset their higher downstream entrainment rate. In 2004 a study was initiated (funded by USACE and conducted by USGS) to evaluate use of fishways by white sturgeon.

- ✓ **Information on Chum Salmon –** In some years hundreds of chum salmon are counted at Bonneville Dam but little is known about their migration and habitat use in the subbasin. To support recovery goals for chum salmon and establish at least one spawning population above Bonneville Dam, additional studies are needed. Study needs include analysis of stock recruitment data, distribution and density of juveniles, adult migration and distribution, and describing the status and trends in aquatic habitats.

- ✓ **Information on Pacific Lamprey –** We have very little understanding of the ways Pacific Lamprey use Bonneville Reservoir for passage or rearing. Investigations are needed to enhance upstream passage of adults and downstream passage of juveniles s at mainstem dam facilities, identify areas in the subbasin that can support spawning, describe distribution and relative density of juvenile in the subbasin, and to identify and monitor habitat quality in areas where Pacific lampreys are found.

- ✓ **Western Pond Turtle Nesting Habitat -** Currently there is only one known nesting area for western pond turtles along the Oregon shore. This plot is on private land. Washington's Western Pond Turtle Management Plan has a goal is to increase nest sites to five along the Washington shore. Obtaining and protecting additional suitable sites and reintroducing turtles would guard against catastrophic habitat losses.

- ✓ **Bald Eagle Nesting and Roost Trees –** Suitable roosting and particularly nesting site are relatively uncommon in the subbasin. Existing sites may be at risk of excessive disturbance from human activities. Education of landowners and people in the vicinity about the risks of disturbance could increase nesting success. Obtaining and protecting nest sites from disturbance could further increase nesting success.

5 Management Plan for the Columbia Gorge Subbasin

This section is a draft management plan that presents a vision for fish and wildlife production, desired outcomes (biological objectives) for focal species and habitats, and strategies to achieve the objectives. It also presents research, monitoring, and evaluation needs. Because strategies sometimes address learning about present unknowns in order to refine biological objectives and the probability of success of strategies, the distinction between active habitat protection or improvements and research, monitoring, and evaluation is not consistently made. This distinction is also not consistently made because some habitat protection and improvement actions will require coordinated systemwide management of the federal Columbia River power system (e.g., measures to protect and enhance white sturgeon and benthic and nearshore habitats).

5.1 Vision

"An ecosystem with productive and sustainable levels of fish and wildlife that provide substantial and sustainable environmental, cultural, recreational, and economic benefits"

is the vision for the management of fish and wildlife and their habitats crafted by stakeholders representing local, state, and federal entities in the Oregon portion of the lower Columbia River Gorge. The draft vision was developed in a meeting facilitated by the Columbia Gorge mainstem and Hood River subbasin technical and planning leads (ODFW and Hood River Soil and Water Conservation District) in Cascade Locks, 11/10/2003 (and a follow-up meeting 4/16/2004). Participants' representation includes City of Cascade Locks, Port of Cascade Locks, Hood River County Planning, Oregon Department of Transportation, Oregon Department of Parks and Recreation, and USFS (Columbia River Gorge National Scenic Area).

5.2 Biological Objectives and Strategies

This plan has been developed using a hierarchical structure of objectives and strategies supported through Research Monitoring and Evaluation (RM&E). Objectives are intended to be quantitative and to have a defined or discernable time-frame component. Each objective is supported by the Columbia Gorge Assessment as indicated by brief statements associated with it. Strategies are linked to one or more objectives, or they may be needed to support objectives developed outside the Columbia Gorge Subbasin Plan (primarily in adjoining subbasins). Strategies are prioritized as follows:

- ✓ Urgent Needs: These strategies must be continued or implemented as soon as possible to achieve objectives and/or curtail losses.

- ✓ High priority needs: These are part of a longer view to achieve objectives, but failure to continue or medium-term delays in implementation will not result in immediate or irrecoverable losses.
- ✓ Information needed: These strategies may have strong merit in particular circumstances, but the benefits and risks need to be investigated to understand details of implementation or potential conflicts with other objectives or strategies.

Measures for RM&E have been developed to guide or delineate concrete actions to implement strategies and monitor progress toward desired outcomes. Each RM&E item is linked or referenced to a set of objectives.

5.2.1 White Sturgeon

White Sturgeon Objectives

1) Optimum sustainable yield. Continue to manage fisheries to attain a maximum harvest rate that allows broodstock abundance to maintain or increase while taking the maximum yield of desirable size classes of fish.

   Sport anglers prefer to harvest large fish rather than small fish, and commercial anglers have difficulty marketing smaller sized white sturgeon. With these parameters in mind, a population model (MOCPOP; Beamesderfer et al. 1995) was used to estimate harvest rates necessary to achieve maximum yield of 36-72” fish. Subsequent regulations narrowed the harvestable size ranges from 42-60” for sport fisheries and 48-60” for commercial fisheries. In 2004 the minimum harvestable size commercial fisheries was reduced to 45" (expanding the slot). Target exploitation rates have been modified to account for these changes. The current target exploitation rates in Bonneville Reservoir are approximately 21% of fish 42-60" in sport fisheries and 25% of fish 45-60" in commercial fisheries (Tom Rien, ODFW, personal communication).

2) Productivity. Attain a level of production (natural recruitment and individual growth) that would allow the sustainable consumptive harvest of 5 kg/ha as suggested in Beamesderfer et al. (1995).

   Assuming that the unimpounded river below Bonneville Dam represents a healthy and productive population, this target would match productivity from the unimpounded lower Columbia River from DeVore et al. (1995). The population in Bonneville Reservoir is known to be less productive based on yield than John Day or The Dalles reservoirs, so a goal of 5 kg/ha may be overoptimistic.

3) Ensure continued progress toward Tribal goals. Quoted from CRITFC (1995):

   “Objectives

   - Within 7 years, halt the declining trends in salmon, sturgeon, and lamprey populations upstream of Bonneville Dam.
   - Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.

- Restore anadromous fishes to historical abundance in perpetuity."

White sturgeon populations in the Zone 6 reservoirs, including Bonneville, are currently holding steady or increasing. Current management goals are designed to stabilize population sizes to allow sustainable harvest in current and future years. Little is known about historical abundances in the section of river now contained behind Bonneville Dam. Much of this area was likely an area of key importance to sustaining the tremendous populations of white sturgeon present in the lower river prior to overexploitation in the late 1800's.

4) Regular annual recruitment. Provide habitat conditions that will allow white sturgeon spawning and suitable rearing conditions for larvae and juveniles.

Fluctuations in recruitment from year-to-year are inevitable and natural in a sturgeon population. However, multiple years of low recruitment can destabilize the population over time, which makes management of the population riskier than it would be under more stable recruitment patterns.

5) Increase broodstock abundance. Determine a target level of broodstock abundance, or a target level of annual increase in broodstock abundance, or a combination of the two.

The abundance of fish not needed to achieve these targets would represent harvestable surplus. This assumes that more broodstock is better, and that it would take a long time to reach a point where density depensation would occur as a result of "too many" broodstock. A target of increasing broodstock by 10% between stock assessment surveys (currently on a 3-year rotation), would currently add about 100 fish to the spawning population in Bonneville Reservoir every three years.

6) Maintain sturgeon that are fit for harvest and consumption. Provide reservoir conditions (sediments and water) that meet Federal and State agency regulations for contaminant levels.

In addition to impacting health of individual fish and the sturgeon population, high levels of contaminants in white sturgeon negatively impact the value of the fishery at the point when consumption of sturgeon flesh becomes unsafe. Due to contamination by PCB's, dioxins, and pesticides, the Oregon Department of Human Services currently recommends all persons reduce or avoid eating fatty parts of any fish harvested from Bonneville Reservoir.

Strategies to Achieve Objectives

Manage white sturgeon in Bonneville Reservoir for sustainable harvest.

Harvest management is currently the primary tool available to achieve biological objectives. Harvest of white sturgeon in Bonneville Reservoir is intensively managed and monitored. Meetings of cooperating managers are held to set harvest guidelines annually based on new information developed by ongoing research activities. Harvest guidelines are adjusted to achieve target exploitation rates. Productivity goals are layered into the target exploitation rates. Past modeling generated exploitation rates needed to generate optimum yield.

Urgent need.

Objectives 1, 2, 3, 4, and 5.

Ensure water quality and contaminant loads in reservoir substrates meet existing guidelines and regulations.

Testing of both somatic and gonad tissues from Bonneville Reservoir white sturgeon has revealed unusually high levels of toxicants that pose risk to human health and that may disrupt gamete development or otherwise reduce productivity. The Oregon Health Division has made a recommendation that crayfish and clams taken upstream from Bonneville Dam to the mouth of Ruckel Creek should not be used for food because of PCB levels in the area. Crayfish and particularly clams are important items in the white sturgeon diet.

Urgent need.
Objectives 6.

Operate the hydrosytem to ensure habitat is available for spawning and rearing white sturgeon.

Maintain a minimum instantaneous river discharge of 250 kcfs during the time period when river temperatures are between 13 and 15° C. The reservoir forebay elevation at John Day Dam should be kept at or lower than 264 ft above mean sea level. This discharge will provide some spawning habitat for white sturgeon in Bonneville Reservoir as well as The Dalles and John Day reservoirs.

High priority need.
Objectives 2, 3, 4, and 5.

Provide passage facilities or transplant operations that offset the observed net downstream movement white sturgeon and ensure opportunities for genetic interchange.

Out of basin need for upstream areas and to relieve potential density dependant reductions in growth and condition.

Information needed.
Objectives: Out-of-basin need.

Consider Bonneville Reservoir as a potential donor population for upstream areas that have reduced productivity or are at risk due to recruitment limitations.

Bonneville Reservoir white sturgeon exhibit characteristics that may be indicators of density dependent affects (reduced individual growth rate, reduced condition factor, and reduced size but older age at sexual maturity). Transplanting juvenile white sturgeon out of the reservoir may alleviate some of the density problem. Still, no reasonably cost-effective means of capturing these fish for transplant has been identified and to achieve an increase in system-wide productivity, growth rates in the donor reservoir would need to offset productivity losses due to transplant mortality.

Information needed
Objectives 2, 3, and out-of-basin need, .

Consider transplants into Bonneville Reservoir or hatchery supplementation if prolonged recruitment failures pose risks to white sturgeon productivity in Bonneville Reservoir.

Recruitment is not now considered a limiting factor for Bonneville Reservoir, so this is primarily a contingency strategy for unforeseen changes.

Information needed [low priority].
Objectives 1, 2, 3, 4, and 5.

White Sturgeon Research, Monitoring, and Evaluation

a) Maintain intensive management of fisheries for impounded white sturgeon populations.

Management strategies should be tailored to the unique attributes of each population to optimize production and help offset the effects of hydroelectric system operation on yield.

Hypothesis: Careful fisheries management will allow continued sustainable fisheries while maintaining or increasing broodstock abundance.
Objectives: 1, 2, 3, 4, and 5.

b) Continue mark-recapture surveys to estimate population abundance.

Surveys are currently conducted in Bonneville, The Dalles, and John Day reservoirs on a three-year rotation. It has been the opinion of the Sturgeon Management Task Force that this schedule should not be extended beyond a three-year rotation, and that the modified Schnabel mark-recapture protocol involving four sampling periods (Kern et al. 2000, 2001, and 2002) be the standard methodology for such surveys.

Hypothesis: Careful fisheries management will allow continued sustainable fisheries while maintaining or increasing broodstock abundance.
Objectives: 1, 2, 3, 4, and 5.

c) Continue transplanting up to 10,000 juvenile white sturgeon from populations in Bonneville Reservoir and downstream from Bonneville Dam.

Consider transplants from Bonneville Reservoir only if experimental transplants demonstrate that handling mortality is low enough to not offset growth benefits of moving fish to under-seeded pools. Until more information on possible compensatory effects on growth in Bonneville Reservoir is available, and assessment of the relationship between mortality of transported fish and growth rates in Bonneville Reservoir is not possible. Rien and North (2002) examined the survival and growth of fish transplanted to The Dalles Reservoir during a 1995-1996 pilot study. This study focused only on short term (1-3 years) results of 2 releases. To date about 41,000 fish have been transplanted by the program, most since 1998. New information on growth and survival in both The Dalles and John Day reservoirs is needed to manage these populations and assess the relative value and effectiveness of Trawl and Haul supplementation.

Hypothesis: Bonneville Reservoir white sturgeon production is not currently limited by juvenile white sturgeon recruitment.
Hypothesis: Bonneville Reservoir white sturgeon productivity is reduced due to density dependent effects.
Objectives: 1, 2, 3, 4, and 5.

d) Investigate whether compensatory population responses may be at work in the Bonneville Reservoir white sturgeon population, or other impounded areas.

Much more work on white sturgeon growth and population ecology is necessary to achieve a good understanding of compensatory population responses.

Hypothesis: Bonneville Reservoir white sturgeon productivity is reduced due to density dependent effects.
Objectives: 1, 2, 3, 4, 5, and 7.

e) Investigate levels of contaminants in sturgeon tissue, assess risks to fish health, and evaluate constraints on population productivity.

Contaminant loads may be contributing to observed reduced growth and condition of white sturgeon in Bonneville Reservoir.

Hypothesis: Contaminants reduce white sturgeon productivity by reducing growth rate and condition.
Hypothesis: Contaminants reduce white sturgeon productivity by affecting gonad and gamete development, maturation, and physiology.
Objectives: 2, 3, 4, and 6.

f) Identify habitat requirements of subadult and adult white sturgeon, quantify amounts of suitable habitat, and evaluate constraints on enhancement.

A recent hypothesis proposed by Coutant (2004) points out the need to examine the potential importance of riparian habitat to sturgeon spawning success and recruitment.

Hypothesis: Depressed condition of riparian and off-channel habitats have reduced available area for egg incubation and rearing areas and contribute to reduced white sturgeon productivity.
Objectives: 1, 2, 3, 4, and 5.

g). Evaluate the use of hatchery technology for supplementing white sturgeon populations.

While not employed in Bonneville Reservoir, hatchery technology is a conservation tool that has been employed (e.g., ESA listed white sturgeon in the Kootenai River) in other areas of the Columbia River basin that should be further refined and evaluated for enhancement of threatened populations of white sturgeon

Hypothesis: Contaminants reduce white sturgeon productivity by affecting gonad and gamete development, maturation, and physiology.
Objectives: 1, 2, 3, 4, 5, and out-of-basin need.

h) Investigate the need and potential measures for restoring sturgeon passage upstream and downstream at mainstem dam facilities. Consider restoration and use of The Dalles Dam fish lift for transferring juvenile sturgeon from Bonneville to The Dalles Reservoir based on a detailed proposal, work plan, and budget for this work.

If compensatory mechanisms are at work in the Bonneville Reservoir population, the ability to emigrate from Bonneville to The Dalles Reservoir or the unimpounded lower river might help alleviate negative effects to growth and yield. Restoration of effective passage could help balance out the net downstream movement demonstrated by the populations in the Zone 6 reservoirs by improving upstream passage, as well as reducing potential losses by passage through the dams.

Existing evidence suggests that white sturgeon populations probably mixed throughout the basin historically. Downstream of the Kootenai River population, the Columbia and Snake river populations very likely represent sub-populations created by dam construction, and not genetically isolated units. Improvement of passage around the dams would restore natural gene flow to the population. Unlike salmonid populations, there is probably little risk of genetic impacts due to movement of fish among these artificial groupings.

Hypothesis: Carefully implemented releases of juvenile white sturgeon will allow continued sustainable fisheries while maintaining or increasing wild broodstock abundance.

Hypothesis: Carefully implemented releases of juvenile white sturgeon will not reduce the genetic health of wild white sturgeon populations.

Objectives: 2, 3, and 4.

i) Consider additional mitigation if, after Zone 6 rearing capacity is saturated, production still falls below levels sustained by the lower river population, which is currently thought to be indicative of pre-impoundment population levels.

Hypothesis: The hydrosystem has altered habitat to an extent that the Bonneville Reservoir can not support predevelopment productivity of white sturgeon.

Hypothesis: Construction and operation of the Columbia River hydropower system has contributed to changes in Columbia River Gorge Subbasin habitat conditions that have reduced white sturgeon resilience and inhibited recovery.

Objectives: 1, 2, 3, 4, 5.

j) Community ecology. Examine the relationships between food values of historically- and currently-available prey species. Develop a bioenergetics analysis of white sturgeon diets and dietary needs. Examine the relationship between food sources and white sturgeon growth.

The relative food value of various prey items taken historically and after reservoir development is unknown. It is possible that the reduction in availability of anadromous prey species has reduced the overall value available to sturgeon populations even in the presence of abundant non-anadromous species that might provide a higher biomass of prey items.

Hypothesis: Construction and operation of the Columbia River hydropower system has contributed to changes in Columbia River Gorge Subbasin habitat conditions that have reduced white sturgeon resilience and inhibited recovery.

Hypothesis: Changes in the Columbia River Gorge Subbasin habitat have decreased the productivity of the ecosystem and contributed to the reduced productivity of white sturgeon.

Hypothesis: Exotic species are capitalizing on the Columbia River Gorge Subbasin habitats and they have impacted ecosystem processes and relationships.

Objectives: 1, 2, 3, 4, 5, 6.

5.2.2 Chum Salmon

Chum Salmon Objectives

1) Reestablish at least one chum salmon spawning population upstream from Bonneville Dam.

   This objective is consistent with and supportive of recovery goals being developed by the NOAA Fisheries' Willamette/Lower Columbia River Technical Recovery Team for ESA-listed salmonids. It is also consistent with subbasin plan objectives for the Wind River.

2) Ensure continued progress toward Tribal goals. Quoted from CRITFC (1995):

   "Objectives

   Within 7 years, halt the declining trends in salmon, sturgeon, and lamprey populations upstream of Bonneville Dam.

   Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.

   Restore anadromous fishes to historical abundance in perpetuity."

Little is known about historical abundances in the section of river now contained behind Bonneville Dam. Passage trends indicate chum salmon have a lower propensity to ascend the fishways at Bonneville Dam compared to other anadromous species. Much of this area was likely an area of key importance to sustaining the chum salmon prior to hydrosystem development.

Strategies to achieve objectives:

All strategies apply to both chum salmon objectives:

Provide suitable reservoir conditions for passage, adult holding, and juvenile rearing that allow adjoining tributaries (particularly the Wind River) to maintain or reestablish chum salmon production.

Subbasin objectives for the Wind River and the Lower Columbia River are to maintain and recover chum salmon production and diversify population distribution. Bonneville Reservoir provides connectivity between these two areas.
Urgent need.

Provide suitable spawning habitat within Bonneville Reservoir.

Mainstem spawning is an important contribution to Lower Columbia River chum production. Bonneville Reservoir may currently support some spawning near the mouth of the Wind River or other tributaries that could contribute to recovery. Reservoir levels have fluctuated up the 4 feet on a daily scale (and briefer). Fluctuations on this order could dewater redds and kill incubating eggs or rearing alevin. If existing habitat quantity is limited, opportunities may exist to create spawning channels.

Information needed.

Chum Salmon Research, Monitoring, and Evaluation

We found little information to ascertain the status of chum salmon within Bonneville Reservoir. A basic assessment of population status and habitat condition/availability for passage, adult holding, and juvenile rearing constitutes the first step in ensuring connectivity between populations in the Lower Columbia River and Bonneville Reservoir tributaries. All proposed actions apply to both chum salmon objectives:

a) Use existing data for adult passage and population age structure to describe a stock-recruitment relationship for chum salmon upstream from Bonneville Dam.

   A stock-recruitment function may allow fisheries managers and recovery planners to characterize population viability and develop quantitative goals for habitat capacity and survival.

   Hypothesis: Chum salmon productivity is the result of habitat availability and survival through a full life history cycle.

   Hypothesis: Historic data exists that will allow characterization of a stock recruitment relationship.

b) Describe the distribution and relative density of chum salmon juveniles in the reservoir.

   Discussions with local experts generally reveal that our current understanding of where chum salmon may rear in Bonneville Reservoir is based on informed opinion but not founded on a reasonable body of physical data.

   Hypothesis: Chum salmon are selective in their use of habitat and do not distribute themselves uniformly or randomly throughout the reservoir.

c) Describe migration and distribution of adult chum salmon upstream from Bonneville Dam.

   In years of relatively high adult chum salmon passage, a telemetry monitoring project or a tag recovery program might allow better characterization of adult migration and distribution (e.g. passage, fall-back, distribution within Bonneville Reservoir and its tributaries).

   Hypothesis: Chum salmon adults that enter Bonneville Reservoir will select spawning areas within the reservoir or its tributaries.

d) In areas where chum salmon are found, describe the status and trends in aquatic habitats, water quality, and stream flow.

Discussions with local experts generally reveal that our current understanding of where chum salmon may rear in Bonneville Reservoir is based on informed opinion but not founded on a reasonable body of physical data.

Hypothesis: Monitoring status and trends in aquatic habitats, water quality, and stream flow will assist in establishing and maintaining high quality habitat.

e) Identify and monitor habitat quality and changes occurring in areas where chum salmon are found.

Potential negative changes include: blocked passage, sedimentation of spawning habitat, intermittent dewatering of redds and rearing habitat, land-use development along low-gradient streams, and decreased recruitment of large woody debris in lower reaches of tributaries and nearshore areas of the reservoir.

Hypothesis: Monitoring habitat quality and changes occurring in areas where chum salmon are found will assist in establishing and maintaining high quality habitat.

f) Identify areas within the reservoir that support or can support chum salmon spawning.

Discussions with local experts generally reveal that our current understanding of how adult chum salmon may use Bonneville Reservoir habitat is based on informed opinion but not founded on a reasonable body of physical data.

Hypothesis: Our current understanding of the interrelationships among fish, wildlife, and limiting habitat conditions in the Columbia River Gorge Subbasin is not robust and introduces substantial uncertainty in decisions intended to benefit recovery and sustainability of natural resources.

g) Experimentally use hatch boxes or other artificial instream incubators to hatch chum salmon in Bonneville Reservoir tributaries.

Hatch boxes may provide a low-risk, low-cost option to populate unused rearing habitat. Additional monitoring for returning progeny is needed to assess the benefit of this type of project.

Hypothesis: Carefully implemented use hatch boxes or other artificial instream incubators expedite and contribute to recovery of naturally producing chum salmon.

Hypothesis: Carefully implemented use hatch boxes or other artificial instream incubators will not reduce the genetic health of naturally producing chum salmon.

h) Experimentally trap and haul adult chum salmon from areas downstream from Bonneville Dam to Bonneville Reservoir tributaries.

A trap and haul project may only be possible in large return years because of its cost to the donor population. Additional monitoring for transplanted adults, their redds in tributaries, and returning progeny are needed to assess the benefit of this type of project.

Hypothesis: Transplanted chum salmon will successfully spawn in Bonneville Reservoir or its tributaries.

i) Identify opportunities to enhance or develop new spawning habitat for chum salmon within the reservoir.

Although the use of engineered habitat is relatively new, substantial potential and limited alternatives may exist to make population level contributions to fish production from relatively small areas of habitat.

Hypothesis: Chum salmon will spawn in an appropriately constructed engineered habitat and progeny will survive to rear and outmigrate.

5.2.3 Pacific Lamprey

Pacific Lamprey Objectives

1) Restore Pacific lamprey populations. Attain self-sustaining natural production of Pacific lamprey that provides for fishing opportunities at traditional locations.

   Pacific lamprey are ecologically significant to freshwater river systems. Returning adults contribute to nutrient budgets, bringing trace minerals from the ocean to streams and uplands when animals prey or scavenge upon them. They are important forage, both as juveniles and adults, for fish, birds, and mammals. Pacific lampreys are highly regarded as traditional food by Native American tribes. Former lamprey abundance provided both tribal and non-Indian fishing opportunities throughout Columbia River Basin tributaries.

2) Ensure continued progress toward Tribal goals. Quoted from CRITFC (1995):

   "Objectives
   - Within 7 years, halt the declining trends in salmon, sturgeon, and lamprey populations upstream of Bonneville Dam.
   - Within 25 years, increase sturgeon and lamprey populations to naturally sustainable levels that also support tribal harvest opportunities.
   - Restore anadromous fishes to historical abundance in perpetuity."

   Little is known about historical abundances in the section of river now contained behind Bonneville Dam. Much of this area was likely an area of key importance to sustaining the Pacific lamprey prior to hydrosystem development.

Strategies to achieve objectives

All strategies apply to both Pacific lamprey objectives

Improve passage of adult lamprey at Bonneville and The Dalles dams.

Adult Pacific lamprey generally navigate hydrosystem dams with poor efficiency. Recent work has shown that improvements such as eliminating 90^o turns and floor grates improve the ability of lamprey to successfully pass dams.

Urgent need.

Investigate passage needs for juvenile lamprey at Bonneville and The Dalles dams.

Juvenile lamprey do not benefit from juvenile salmonids passage systems. Juvenile lamprey are relatively poor swimmers and suffer high impingement rates on bypass screens. Passage modifications that benefit juvenile lamprey, while not impeding juvenile salmonids, should be evaluated.

Urgent need.

Reduce exposure of juvenile lamprey to contaminants.

Juvenile Pacific lamprey may be particularly susceptible to contaminant exposure because they are closely associated with fine sediments and because they spend extensive periods within these sediments. Exposure to contaminants may be especially excessive in the forebay of Bonneville Dam.

Urgent need.

Investigate use of Bonneville Reservoir by juvenile lamprey.

Although historic and recent counts of adult Pacific lamprey passing The Dalles Dam are substantially lower than counts at Bonneville Dam, no estimates of the number of lamprey spawning in Bonneville Reservoir or in tributaries are available. Juveniles originating from both the reservoir and tributaries may rear in Bonneville Reservoir, as may some juveniles originating upstream of The Dalles Dam. Abundance, distribution, and habitat use of rearing juveniles should be determined.

High priority need.

Minimize stranding of juvenile lamprey.

Some observations of mainstem habitat use have been made where water surface elevations were rapidly lowered via manipulation of base flows by hydroelectric dams. Several juvenile lamprey were exposed during the test drawdown of Little Goose and Lower Granite dams in March 1992 (Dauble and Geist, 1992). Short-term fluctuations in reservoir level can isolate or dewater rearing areas can kill juvenile lamprey. An investigation of substrates in the lower reach of Fifteenmile Creek and its confluence with the Columbia River mainstem identified the presence of larval lamprey at densities up to 117 fish/m^2 in depths ranging from 0.5 to 3.2 m (personal communication, J. Smith, InterFluve Company). The fish were well distributed across body lengths, suggesting the presence of multiple year classes. In the lower Willamette River, age 0+ lampreys of unknown species have been observed in sandy substrates at a depth of 45 ft (personal communication, T. Friesen, ODFW). Juvenile lampreys have been observed most months of the year in a variety of nearshore habitats in the lower Willamette River.

High priority need.

Avoid direct dredging mortality.

Juvenile Pacific lamprey are closely associated with sand and fine sediments and they spend extensive periods within these sediments. Dredging of these sands and fine sediments results in entrainment and mortality.

High priority need.

Protect functioning habitats and restore impaired habitats.

Juvenile Pacific lamprey are closely associated with sand and fine sediments and they spend extensive periods within these sediments. Altering substrate composition (e.g. rip-rap, wing dams, improved moorage, port structures) may reduce available rearing habitat or its quality. High priority need.

Pacific Lamprey Research, Monitoring, and Evaluation

We found little information to ascertain the status of Pacific lamprey within Bonneville Reservoir. A basic assessment of population status and habitat condition/availability, primarily for juvenile rearing, constitutes the first step in ensuring the continued existence and eventual restoration of lamprey populations. All recommended actions apply to both lamprey objectives:

a) Investigate potential measures for enhancing upstream passage of adult Pacific lamprey and downstream passage of juvenile Pacific lamprey at mainstem dam facilities.

Fishway and bypass use by Pacific lamprey remains poorly understood. In some cases fishways were designed to impeded lamprey usage, though this has been corrected where known.

Hypothesis: Passage is currently limiting production of Pacific lamprey.

b) Identify areas within Bonneville Reservoir that support or can support Pacific lamprey spawning.

Fine sediment substrates found in larger rivers can provide a substantial quantity of rearing habitat.

Hypothesis: Understanding habitat use and distribution is a key information need to identifying and prioritizing habitat protection.

c) Describe distribution and relative density of juvenile Pacific lamprey in Bonneville Reservoir.

Habitat use by juvenile Pacific lamprey in large rivers has not specifically been studied.

Hypothesis: Understanding habitat use and distribution is a key information need to identifying and prioritizing habitat protection.

d) Identify and monitor habitat quality and changes occurring in areas where juvenile Pacific lamprey are found.

Potential negative changes include: blocked passage, development of spawning habitat, intermittent dewatering of redds and rearing habitat, and land-use development along low-gradient streams.

Hypothesis: Understanding habitat changes and trends will allow managers to guard against further habitat loss.

5.2.4 Bald Eagle

Bald Eagle Objectives

1) Maintain and improve present level of survivorship of mature adults.

   There are many positive population trends observed for bald eagles. The breeding population in Oregon statewide and along the Columbia River has increased dramatically over the last two decades. This success needs to continue to fully recover the population.

2) Increase the number of nesting birds to 23 pairs over the next 15 years (assumes approximate 5% annual increase that has occurred in Oregon continues).

   The goal developed for Columbia River nest density is one nest every two river miles (personal communication, C. Flick, U.S. Forest Service) 23 pairs represents the Gorge Subbasin's component of that goal.

3) Maintain a fledgling rate of at least one juvenile per nest per year.

   The nesting success rate in the Columbia River Gorge has averaged approximately two fledglings for every three nests. A fledgling rate of at least one juvenile per nest per year would bring the Columbia River Gorge nest success in line with nearby areas. In Oregon, the productivity rate (young per occupied territory) has averaged 0.97 since 1971. Productivity in territories along the Columbia River (Columbia River Recovery Zone 10) has been less at a rate of 0.81 since 1973 (Isaacs and Anthony, 2003). In the Columbia River Gorge (Hood River, Skamania, Klickitat, and portions of Multnomah and Wasco counties) productivity since the early 1990's has averaged slightly more than one young per occupied territory (1.07) and has been higher than the statewide and Columbia River average for the same period (0.99 and 0.88).

Strategies to Achieve Objectives

All recommended strategies apply to all three bald eagle objectives:

Protect existing perching, roosting, and nesting habitats (breeding territories) from destruction and disturbance in the near term, with emphasis on sites on islands or near the Columbia River shore.

Bald eagles are vulnerable to loss of nesting and winter roost habitat, and are sensitive to human disturbance from residential development and timber harvest along shorelines; however, bald eagle populations are recovering toward target levels established by the Pacific States Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service 1986).

Urgent need.

<u>Continue enforcement of federal and state laws that protect bald eagles.</u>

The bald eagle was listed as a threatened species under the federal ESA in 1978 in the Pacific Northwest. It is a State Threatened species in Oregon and Washington. Continued enforcement of regulations is essential reducing disturbance and human-caused mortality.

Urgent need.

<u>Inventory potential new perching, roosting, and nesting habitats, and establish protection measures.</u>

Bald eagles are vulnerable to loss of nesting and winter roost habitat, and are sensitive to human disturbance from residential development and timber harvest along shorelines; however, bald eagle populations are recovering toward target levels established by the Pacific States Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service 1986).

High priority need.

<u>Manage forests and woodlands for the medium and longer term to compensate for succession of existing perching, roosting, and nesting habitats.</u>

Bald eagles are vulnerable to loss of nesting and winter roost habitat, and are sensitive to human disturbance from residential development and timber harvest along shorelines; however, bald eagle populations are recovering toward target levels established by the Pacific States Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service 1986).

High priority need.

<u>Promote public awareness of effects of habitat alteration and disturbance of birds.</u>

Bald eagles are sensitive to human disturbance from residential development and timber harvest along shorelines; however, bald eagle populations are recovering toward target levels established by the Pacific States Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service 1986). A bald eagle nest can draw the attention well-meaning but poorly informed observers. Protection from nest disturbance may be a key method for increasing nesting success.

High priority.

Research, Monitoring, and Evaluation

All recommended actions apply to all three bald eagle objectives:

a) Continue annual nesting surveys in the Columbia River Gorge National Scenic Area.

   Needed to monitor progress toward nesting success rate objective.
   <u>Hypothesis</u>: Monitoring nesting success is needed to quantify progress and will inform actions to improve success.

b) Continue bald eagle mid-winter survey each January in the Columbia River Gorge lead by ODFW (1979 - 1983 and 1988 – present).

Needed to monitor overall abundance of bald eagles.
Hypothesis: Monitoring wintering abundance is needed to quantify progress and will inform actions to improve success.

c) Inventory existing potential unused breeding territories.

Potential unused nest sites will need to be maintained and protected to ensure progress toward nesting density objective.
Hypothesis: Inventory of breeding territories will inform actions to protect habitat and improve success.

d) Inventory potential future breeding territories.

Potential unused nest sites will need to be maintained and protected to ensure progress toward nesting density objective.
Hypothesis: Inventory of unused nest sites will inform actions to protect habitat and improve success.

e) Assess habitat capacity for breeding territories and overwintering area.

It is unclear what the current habitat capacity is and what opportunities exist to increase habitat capacity.

Hypothesis: Availability of wintering habitat does not limit bald eagle production, abundance, or survival.

f) Identify factors associated with nest failure.

Nest success in the Columbia River Gorge is somewhat less than surrounding areas. Human disturbance is one potential contributing factor, but its importance compared to other potential factors (e.g. contamination, food quality and availability) is not clear.

Hypothesis: Understanding factors affecting nest failure will inform future recovery actions.

5.2.5 Western Pond Turtle

Western Pond Turtle Objective

Restore western pond turtle populations. Re-establish self-sustaining populations of western pond turtles in the Columbia Gorge

The Western Pond Turtle Recovery Plan identifies goals for three populations in the Columbia Gorge. Each population must reach at least 200 animals and meet conservation targets for age structure, reproduction, and habitat security. Each population should be composed of no more than 70% adults, which occupy habitat that is secure from development or major disturbance (populations must show evidence of being sustained by natural recruitment of juveniles).

Strategies to Achieve Objectives

Continue the "head start" program to augment populations

Individuals from the head start program have contributed to increases in the Klickitat and Skamania populations. Continuation of the program will likely contribute to reaching population goals. The need to use "head start" to augment the Oregon population should be investigated.

Urgent need.

Improve nesting and foraging habitat through pond and meadow development.

Degradation of western pond turtle habitat along the Columbia River must be halted and if possible reversed. Where possible, habitat should be restored including migration corridors. In addition, key acquisitions should be considered to protect habitat. Protection or restoration of suitable habitats may provide refugia from predation, alteration of aquatic habitats, vehicular traffic, and other sources of mortality.

High priority need.

Reduce predation by introduced species such as bullfrogs.

As significant predators on hatchling and small juvenile western pond turtles, non-native species such as bullfrogs reduce survivorship and alter recruitment patterns. Full restoration of turtle populations may require some removal of exotic predators.

High priority need.

Western Pond Turtle Research, Monitoring, and Evaluation

a) Continue monitoring the effects of the "head start" program.

Many of the western pond turtles in known Washington populations went through the head-start program at the Woodland Park and Oregon zoos. The program should be continued and monitored to evaluate continued success in reaching population objectives.

Hypothesis: Survival of turtles going through the "head start" program is higher than those reared in the wild.

b) Thoroughly survey ponds and wetlands for additional populations of western pond turtles.

Surveys recently discovered a population of turtles in Hood River County, Oregon. Additional turtles may still occur in wetlands that have not been surveyed. All likely habitat in the subbasin should be surveyed to allow better understanding of population status.

Hypothesis: Understanding distribution is a key information need to identify and prioritize habitat protection.

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7 Tables

Table 1. Name and location (Columbia river mile) of selected tributaries of Bonneville Reservoir (WDFW and ODFW, 1990; CBFWA subbasin summaries).

Name	Approximate river mile	Columbia bank
Eagle Creek	146.3	South
Rock Creek	150.0	North
Hermann Creek	150.7	South
Wind River	155.0	North
Collins Creek	157.9	North
Lindsey Creek	158.8	South
Dog Creek	160.8	North
Viento Creek	161.0	South
Little White Salmon River	162.2	North
White Salmon River	167.0	North
Hood River	167.5	South
Jewett Creek	170.6	North
Mosier Creek	174.9	South
Catherine Creek	177.4	North
Major Creek	177.7	North
Klickitat River	180.4	North
Chenoweth Creek	187.3	South
Mill Creek	189.2	South
Fifteenmile Creek	190.9	South

Table 2. Period of record monthly climate summary: (Bonneville Dam, 7/1/1948 - 3/31/2003; Hood River, 1/1/1928 - 3/31/2003; The Dalles, 7/1/1948 - 3/31/2003).

	Average T_{max} (°F)			Average T_{min} (°F)			Average precipitation (in)			Average snowfall (in)		
Month	Bonneville Dam	Hood River	The Dalles	Bonneville Dam	Hood River	The Dalles	Bonneville Dam	Hood River	The Dalles	Bonneville Dam	Hood River	The Dalles
1	42.4	39.8	42.1	32.7	27.8	29.3	11.8	5.2	2.7	10.0	14.6	8.7
2	47.3	46.1	48.7	35.2	30.6	32.1	9.2	3.7	1.9	3.3	6.0	2.1
3	53.2	53.7	57.4	37.7	34.3	36.4	8.1	3.2	1.4	0.9	1.7	1.0
4	59.6	61.0	65.7	41.9	38.6	42.0	5.7	1.6	0.7	0.0	0.1	0.0
5	66.4	68.6	73.6	47.0	44.1	48.7	3.8	1.1	0.6	0.0	0.0	0.0
6	71.9	74.0	80.3	52.3	49.8	55.2	2.8	0.8	0.4	0.0	0.0	0.0
7	78.2	80.7	87.7	56.5	53.3	59.7	0.9	0.2	0.2	0.0	0.0	0.0
8	78.7	80.7	87.5	56.4	52.4	58.9	1.4	0.4	0.3	0.0	0.0	0.0
9	74.0	75.0	81.5	52.9	46.0	51.4	2.9	0.9	0.5	0.0	0.0	0.0
10	62.9	63.5	67.9	46.5	39.0	42.4	6.4	2.4	1.1	0.0	0.1	0.0
11	51.0	49.1	52.0	40.0	33.9	36.0	11.5	4.9	2.1	0.8	2.3	1.2
12	44.0	41.7	43.5	34.7	30.5	31.4	12.9	5.8	2.7	3.3	7.6	3.0
Annual	60.8	61.2	65.7	44.5	40.0	43.6	77.4	30.1	14.4	18.3	32.5	15.9

Source: Western Regional Climate Center. URL: *http://www.wrcc.dri.edu/cgi-bin/*

Table 3. Approximate proportion of total shoreline by ownership types in Bonneville Reservoir (does not include towns and cities). Adapted from GIS data layers for the Columbia Gorge National Scenic Area (personal communication, C. Bauers, USFS).

	Proportion of Bonneville Reservoir shoreline		
Type of ownership	Oregon	Washington	Both
Private	0.39	0.64	0.51
State Park	0.33	0.00	0.17
Federal	0.13	0.15	0.14
Other Federal	0.06	0.14	0.10
State	0.03	0.07	0.05
County	0.06	0.00	0.03
Total	0.52	0.48	1.00

Table 4. Proportion and distribution of substrate types in Bonneville Reservoir.

	Columbia River Reach				
Type of substrate	Bonneville Dam to Wind River (Rm 141 - 155)	Wind River to Hood River (Rm 155 - 173)	Hood River to Klickitat River (Rm 173 - 180)	Klickitat River to The Dalles Dam (Rm 173 - 192)	Total
Bedrock	--	0.002	0.039	0.106	0.028
Bedrock and boulders	0.016	--	--	--	0.004
Boulder	--	0.004	--	0.005	0.002
Boulder and cobble	--	--	--	0.066	0.011
Cobble and gravel	--	--	--	0.075	0.012
Cobble/rubble	--	--	--	0.075	0.012
Gravel	0.071	--	--	0.100	0.033
Gravel and sand	0.028	0.014	--	--	0.012
Islands	0.006	0.010	0.005	0.020	0.009
Mud and organic material	--	0.029	--	--	0.010
Mud/soft clay	0.010	0.034	0.003	--	0.015
Sand	0.750	0.866	0.931	0.470	0.789
Sand and mud	0.069	0.019	0.022	0.083	0.042
Sand and organic material	0.050	0.022	--	--	0.020

Table 5. Classifications of fish species observed in the Columbia River between Bonneville and The Dalles dams. Classifications include those of Zaroban et al. (1999) and observations are from URL: *http://www.cbfwf.org/files/province/gorge/subsums/BonnevilleReservoir.PDF*.

Family/Species	Overall tolerance	Adult freshwater habitat	Temperature	Freshwater feeding behavior	Duration of residency	Spawning type
Lampreys						
Pacific lamprey	S	hider	cool	filter feeder	intermediate	Nest builder/nonguarding
Sturgeons						
White sturgeon	I	benthic	cold	invert/piscivore	permanent[b]	Broadcast spawner
Herrings[c]						
American shad	I	water column	cool	invertivore	transitory	Pelagic spawner
Salmon, trouts, and whitefishes						
Brown trout[c]	I	hider	cold	invert/piscivore	intermediate	Nest builder/nonguarding
Bull trout	S	hider	cold	invert/piscivore	intermediate	Nest builder/nonguarding
Cutthroat trout	S	water column	cold	invert/piscivore	unknown	Nest builder/nonguarding
Chinook salmon	S	water column	cold	invertivore	intermediate	Nest builder/nonguarding
Coho salmon	S	water column	cold	invertivore	intermediate	Nest builder/nonguarding
Sockeye salmon	S	water column	cold	invertivore	transitory	Nest builder/nonguarding
Chum salmon	S	water	cold	invertivore	n/a	Nest

(extirpated)		column				builder/nonguarding
Rainbow trout	S	hider	cold	invert/piscivore	intermediate	Nest builder/nonguarding
Mountain whitefish	I	benthic	cold	invertivore	permanent	Broadcast spawner
Smelts						
Eulachon (extirpated)	I	water column	cool	invertivore	n/a	Broadcast spawner
Minnows						
Grass carp[c]	T	water column	warm	herbivore	permanent	Pelagic spawner
Chiselmouth	I	benthic	cool	herbivore	permanent	Broadcast spawner
Common carp[c]	T	benthic	warm	omnivore	permanent	Broadcast spawner
Goldfish[c]	T	benthic	warm	omnivore	permanent	Broadcast spawner
Peamouth	I	water column	cool	invertivore	permanent	Broadcast spawner
Northern pikeminnow	T	water column	cool	invert/piscivore	permanent	Broadcast spawner
Speckled dace	I	benthic	cool	invertivore	permanent	Broadcast spawner
Redside shiner	I	water column	cool	invertivore	permanent	Broadcast spawner
Tench	I	water column	warm	invertivore	permanent	Broadcast spawner
Suckers						
Largescale sucker	T	benthic	cool	omnivore	permanent	Broadcast spawner
Longnose sucker	I	benthic	cold	invertivore	permanent	Broadcast spawner
Bridgelip sucker	T	benthic	cool	herbivore	permanent	Uncertain
Catfishes[c]						
Channel catfish	T	benthic	warm	invert/piscivore	permanent	Nest builder/guarder
Brown bullhead	T	hider	warm	invert/piscivore	permanent	Nest builder/guarder
Black bullhead	T	hider	warm	invert/piscivore	permanent	Nest builder/guarder
Sticklebacks						

Threespine stickleback	T	hider	cool	invertivore	permanent	Nest builder/guarder
Troutperches						
Sand roller	I	hider	cool	invertivore	permanent	Unknown
Sunfishes[c]						
Pumpkinseed	T	water column	cool	invert/piscivore	permanent	Nest builder/guarder
Bluegill	T	water column	warm	invert/piscivore	permanent	Nest builder/guarder
Black crappie	T	water column	warm	invert/piscivore	permanent	Nest builder/guarder
White crappie	T	water column	warm	invert/piscivore	permanent	Nest builder/guarder
Smallmouth bass	I	water column	cool	piscivore	permanent	Nest builder/guarder
Largemouth bass	T	water column	warm	piscivore	permanent	Nest builder/guarder
Perches[c]						
Yellow perch	I	water column	cool	invert/piscivore	permanent	Broadcast spawner
Walleye	I	water column	cool	piscivore	permanent	Broadcast spawner
Sculpins						
Prickly sculpin	I	benthic	cool	invert/piscivore	permanent	Nest builder/nonguarding
Mottled sculpin	I	benthic	cool	invertivore	permanent	Nest builder/guarder

[a] I = Intermediate, T = Tolerant, S = Sensitive.

[b] White sturgeon are anadromous species that have been artificially land-locked between the dams.

[c] Alien family or species.

Table 6. Annotated relative significance of selected fish species in Bonneville Reservoir.

Species	Social/legal	Ecological	Cultural	Economic	Recreation	Knowledge
Pacific lamprey	Listing petion to USFWS	Unique habitat requirements; prey fish	Tribal traditional food			Low
White sturgeon	Intensively managed for harvest	Long-lived, benthic, biocumulation of toxins	Tribal traditional food	Commercial harvest and multiplier effect for sport	Major fishery	High
American shad		Adults and juveniles extremely abundant		Modest contribution to sport and commercial harvest	Popular fishery	Low
Bull trout	ESA listed	Water quality indicator (temperature)				Low
Cutthroat trout	USFWS/State species of concern					Low
Chinook salmon (ocean-type)	ESA listed	Quality of rearing habitat	Tribal traditional food; Pacific Northwest icon	Commercial harvest	Sport harvest	Medium
Coho salmon	NMFS/State species of concern	Availability of spawning and rearing habitat				Medium
Chum salmon	ESA listed	Connectivity and population structure				Medium
Rainbow trout (steelhead)	ESA listed		Tribal traditional food		Popular fishery	Medium
Northern pikeminnow		Top predator			Sport-reward control fishery	High
Channel catfish		Top salmon predator			Sport harvest	Medium
Smallmouth bass	Managed gamefish	Top fish predator			Popular fishery	Medium
Walleye	Managed gamefish	Top fish predator		Modest commercial harvest	Popular fishery	Medium

Table 7. Bonneville Dam adult fish ladder counts less counts at The Dalles Dam, 1977-2003.

Year	Chinook salmon	Coho salmon	Steelhead trout	Sockeye salmon	All salmon and steelhead	Pacific lamprey
1977	142,000	9,000	59,000	14,000	224,000	--
1978	195,000	34,000	44,000	7,000	280,000	--
1979	126,000	37,000	31,000	20,000	214,000	--
1980	132,000	16,000	35,000	17,000	200,000	--
1981	150,000	24,000	46,000	21,000	241,000	--
1982	150,000	66,000	40,000	17,000	273,000	--
1983	87,000	12,000	48,000	16,000	163,000	--
1984	120,000	26,000	97,000	51,000	294,000	--
1985	91,000	52,000	57,000	49,000	249,000	--
1986	129,000	126,000	95,000	10,000	360,000	--
1987	126,000	24,000	81,000	29,000	260,000	--
1988	116,000	30,000	81,000	24,000	251,000	--
1989	135,000	27,000	56,000	2,000	220,000	--
1990	133,000	20,000	54,000	9,000	216,000	--
1991	122,000	56,000	75,000	13,000	266,000	--
1992	88,000	14,000	83,000	19,000	204,000	--
1993	93,000	7,000	64,000	18,000	182,000	--
1994	82,000	18,000	59,000	3,000	162,000	--
1995	98,000	9,000	57,000	2,000	166,000	--
1996	129,000	14,000	43,000	5,000	191,000	--
1997	163,000	23,000	107,000	15,000	308,000	15,000
1998	127,000	41,000	82,000	4,000	254,000	--
1999	144,000	30,000	63,000	4,000	241,000	--
2000	176,000	68,000	93,000	20,000	357,000	11,000
2001	342,000	202,000	155,000	12,000	711,000	19,000
2002	342,000	83,000	120,000	9,000	554,000	77,000
2003	382,000	88,000	113,000	5,000	588,000	88,000
Average	153,000	43,000	72,000	15,000	283,000	42,000

Table 8. Salmon and steelhead hatchery production in tributaries of Bonneville Reservoir, 1979 - 2003.

Release year	Coho	Steelhead 1/	Subyearling Chinook	Yearling Chinook	Total
1979	3,288,000	--	41,221,000	4,221,000	48,730,000
1980	5,560,000	--	34,310,000	4,708,000	44,578,000
1981	4,390,500	--	30,498,000	4,293,500	39,182,000
1982	4,173,500	--	24,475,500	5,321,500	33,970,500
1983	4,880,000	--	31,897,000	3,401,000	40,178,000
1984	3,905,834	--	24,804,869	3,334,554	32,045,257
1985	3,514,746	--	17,598,832	4,455,784	25,569,362
1986	7,308,127	--	17,985,138	3,799,572	29,092,837
1987	4,069,500	--	19,314,000	3,618,500	27,002,000
1988	6,081,000	--	23,161,035	3,823,500	33,065,535
1989	3,639,099	--	24,320,225	3,213,598	31,172,922
1990	5,547,616	--	17,809,191	4,502,927	27,859,734
1991	4,038,923	--	27,324,768	4,231,094	35,594,785
1992	4,081,867	--	35,404,613	4,394,875	43,881,355
1993	4,423,615	--	21,803,279	3,889,028	30,115,922
1994	3,182,332	--	26,793,518	4,177,956	34,153,806
1995	1,922,032	--	22,420,808	3,971,206	28,314,046
1996	3,923,213	--	23,317,697	3,294,136	30,535,046
1997	3,412,582	--	29,199,586	2,170,931	34,783,099
1998	2,927,749	--	22,939,629	3,728,515	29,595,893
1999	3,195,530	64,484	20,402,078	3,129,800	26,785,699
2000	2,966,084	5,900	22,199,879	3,111,532	28,277,495
2001	2,485,708	8,828	20,350,540	3,255,324	26,091,572
2002	1,994,412	--	25,392,389	3,310,381	30,697,182
2003	1,631,793	--	21,675,588	3,293,094	26,600,475
Minimum	1,631,793	--	17,598,832	2,170,931	25,569,362
Maximum	7,308,127	--	41,221,000	5,321,500	48,730,000
Average	3,861,750	--	25,064,766	3,786,052	32,714,901

1/ Data are not comprehensive. Fish released in Hood River are not completely reported.

Source: Fish Passage Center, URL: *http://www.fpc.org/HatcheryRelease.asp*

Table 9. 2002–2004 Zone 6 white sturgeon harvest guidelines.

Reservoir Fishery	2002 Quota	2003 Quota	2004 Quota
Bonneville			
Sport	1,520	1,700	700
Commercial	1,300	1,150	400
The Dalles			
Sport	700	400	400
Commercial	1,100	900	900
John Day			
Sport	165	165	165
Commercial	335	335	335

Table 10. Bonneville Reservoir abundance estimates by total length increment (inches), 1976-2003.

Total Length (inches)	Year				
	1976	1989	1994	1999	2003
30 - 72	12,200	35,400	35,200	85,400	
(95% CI)	NA	(27,500-45,400)	(24,800-66,000)		
24-36	17,900	32,900	31,300	82,358	87,282
36-48	3,900	16,700	18,300	41,817	30,710
48-60	1,200	NA	NA	3,228	1,020
60-72	1,200	NA	NA	621	151
48-72	2,400	1,200	1,500	3,849	1,171
72+	1,600	600	900	292	746
24-72+	25,800	51,400	52,000	128,316	119,909

Table 11. Comparison of Bonneville Reservoir white sturgeon growth rates (fork length cm/year) from different methods.

Length range (cm FL)	Mean annual growth rate from aging methods	Mean annual growth rate from recaptured fish
70-110	4.7	1.1
110-137	4.0	2.2
138166	3.4	5.6
167+	1.7	4.6

Table 12. Physical habitat at sites where white sturgeon were collected in the Columbia River, 1987-1991. [a]

Life Stage	Location	Water Temperature (°C) [b]	Depth (m)	Mean water column velocity (m/s)	Velocity near substrate (m/s)	Substrate type [c]
Spawning	Lower River	14 (10-18)	6 (4-23)	2.10 (1.0-2.80)	1.40 (0.60-2.40)	Boulder
	Impoundments	14 (12-18)	11 (4-24)	1.46 (0.81-2.10)	1.04 (0.52-1.62)	Cobble
Incubating eggs	Lower River		14 (4-23)	2.00 (0.80-2.80)	1.20 (0.50-2.40)	Boulder
	Impoundments		11 (4-27)	1.39 (0.50-2.10)	1.04 (0.18-1.77)	Cobble
yolk-sac larvae	Lower River		16 (4-29)	1.60 (0.70-2.70)	1.00 (0.40-2.40)	Sand
	Impoundments		12 (5-58)	1.1 (0.41-2.10)	0.84 (0.27-1.68)	Cobble
Young of year	Lower River		19 (9-38)	no data	no data	Sand
	Impoundments		30 (9-57)	0.38 (0.18-0.63)	0.37 (0.12-0.55)	Sand
Juvenile	Lower River		16 (2-40)	0.65 (0.40-1.10)	0.60 (0.20-0.80)	Sand
	Impoundments		19 (6-58)	0.61 (0.09-1.20)	0.37 (0.06-0.64)	Sand

[a] Values are medians and (in parentheses) ranges.

[b] Water temperature on days that newly spawned eggs were collected

[c] Mode

Table 13. Spawning time, age at return, and proportion females for chum salmon sampled in the Columbia River mainstem downstream of Bonneville Dam, 1998 - 2003.

Run Year	Peak spawning	Age 3	Age 4	Age 5	Age 6	N	Proportion females
1998	16-Nov	0.086	0.733	0.172	0.009	116	0.61
1999	23-Nov	0.583	0.417	0.000	0.000	12	0.75
2000	1-Dec	0.304	0.643	0.054	0.000	168	0.44
2001	26-Nov	0.531	0.438	0.031	0.000	290	0.58
2002	6-Dec	0.335	0.620	0.045	0.000	403	0.52
2003	--	0.037	0.853	0.110	0.000	109	0.61
Weighted mean:		0.329	0.608	0.062	0.001	1,098	0.55

Source: van der Naald et al. (1999, 2000, 2001, 2002, and 2003) and personal communication, W. van der Naald, ODFW (2004).

Table 14. Summary of observations of juvenile lampreys by location and month in the lower Willamette River, 5/24/2000 - 12/11/2002. Fish were sampled by boat electroshocker an average of 777 s/run.

Rivermile	Bank	Shore character	Months sampled	Catch
0.6	East	Vegetated beach	1 - 12	1
1.0	East	Pilings with light	1 - 12	5
5.1	East	Floating without light	1 - 12	1
6.4	West	Non-vegetated rip rap	1 - 12	2
11.6	East	Vegetated rip rap	1 - 12	1
11.8	West	Non-vegetated rip rap	1-3,5,6,8-12	27
13.6	East	Vegetated rip rap	1 - 12	20
14.8	East	Vegetated beach	1 - 12	34
14.8	West	Unclassified fill	1 - 12	1
16.7	West	Vegetated beach	1 - 12	2
23.2	West	Beach	1 - 12	15
23.9	East	Beach	1 - 12	37

Table 15 . Changes in quantities (acres) of habitat types in the Columbia River Gorge, ca 1850 - Present, based on IBIS.

	Period		
Habitat Name	Historic	Present	Change
Mesic Lowlands Conifer-Hardwood Forest	79,010	111,160	246%
Interior Mixed Conifer Forest	74,660	28,880	-163%
Interior Grasslands	45,290	27,880	-260%
Ponderosa Pine & Interior White Oak Forest and Woodlands	30,330	63,170	92%
Open Water - Lakes, Rivers, and Streams	27,610	18,000	-287%
Shrub-steppe	17,770	24,020	284%
Montane Mixed Conifer Forest	14,510	8,730	-251%
Interior Riparian-Wetlands	10,380	40	-100%
Westside Riparian-Wetlands	3,470	0	-100%
Desert Playa and Salt Scrub Shrublands	2,650	0	-100%
Western Juniper and Mountain Mahogany Woodlands	740	0	-100%
Herbaceous Wetlands	560	50	-110%
Lodgepole Pine Forest and Woodlands	470	0	-100%
Agriculture, Pastures, and Mixed Environs	0	13,530	0%
Bays and Estuaries	0	40	0%
Montane Coniferous Wetlands	0	70	0%
Urban and Mixed Environs	0	7,770	0%
Westside Oak and Dry Douglas-fir Forest and Woodlands	0	4,110	0%
Grand Total	307,450	307,450	

Table 16. Current wildlife habitat types by area (acres) and land ownership in the Columbia Gorge subbasin.

Habitat type	Federal	Tribal	State	Local government	Non-governmental organizations	Private	Water	Total
Mesic Lowland Conifer-Hardwood Forest	58,975	16	22,548	1,041	0	48,970	0	131,550
Ponderosa Pine and Interior White Oak Forest & Woodlands	2,336	173	506	161	173	41,895	0	45,244
Interior Grasslands	1,110	0	1,221	36	144	25,078	0	27,589
Shrub-steppe	1,472	264	628	401	0	23,087	0	25,852
Interior Mixed Conifer Forest	10,306	130	205	17	18	11,957	0	22,633
Lakes, Rivers, Ponds, and Reservoirs	227	5	220	0	0	1,551	18,464	20,467
Agriculture, Pasture, and Mixed Environs	26	1	66	100	0	13,592	0	13,785
Montane Mixed Conifer Forest	8,484	0	144	2	0	104	0	8,734
Urban and Mixed Environs	109	2	2	0	0	6,977	0	7,090
Westside Oak and Dry Douglas-fir Forest & Woodlands	480	11	6	0	17	3,602	0	4,116
Montane Coniferous Wetlands	27	0	34	0	0	148	0	209
Herbaceous Wetlands	0	0	0	0	0	65	0	65
Interior Riparian Wetlands	2	0	9	0	0	19	29	59
Bays and Estuaries	0	0	0	0	0	7	35	42
Alpine Grasslands and Shrublands	7	0	0	0	0	0	0	7
Total	83,561	602	25,589	1,758	352	177,052	18,528	307,442

Source: IBIS, URL *http://nwhi.org/ibis/subbasin/subs2.asp*

Table 17. Limiting factors for Bonneville Reservoir white sturgeon population. A "1" = low significance, a "2" = moderate significance, and a "3" = highly limiting factor. A "?" = unknown importance of the factor.

	Life History Stage					
Factor	Egg/Larvae	YOY	Juvenile	Harvestable	Non-spawning adult	Reproductive adult
Water temperature	2	?	1	1	1	3
Base flow	2	?	1	1	1	3
Flow variation	?	?	1	1	1	3
Sediments	3	?	2	1	1	2(?)
Harvest	3	1	1	3	3	3
Connectivity /Passage	1	3(?)	3(?)	3(?)	3(?)	3(?)
Predation	?	?	?	1	1	1
Loss of prey base	1	?	?	?	?	?
Introduced species	?	?	?	?	?	?
Recruitment	3	3	3	3	3	3
Water quality	3	1(?)	1	1	1	3
Contaminants	3(?)	3(?)	3(?)	3(?)	3(?)	3(?)

Table 18. Potential factors limiting production of bald eagles in the Columbia River Gorge. Factors that might be most directly mitigated are presented in ***bold italics*****.**

Life history, Life stage	Potential limiting factor	Relative magnitude of limiting factor 1/
Nesting,		
Breeding pair	• ***Recruitment to maturity.***	?
	• ***Nesting sites.***	?
	• Competition for sites**.**	?
	• ***Disturbance.***	?
	• Productivity – forage quantity and quality***, contaminants.***	?
Egg	• *Contaminants.*	?
Chick	• Sibling competition/Density**.**	?
Fledgling	• *Alternate roost sites.*	?
	• *Food availability and quality.*	?
Rearing,		
Subadult	• *Disturbance.*	?
	• *Perching and roost sites*	
	• Competition – inter- and intraspecific.	?
Overwintering,		
Subadult and mature	• Forage quantity and quality.	?
	• *Perching and roost sites.*	?
	• *Disturbance.*	?
	• Competition – inter- and intraspecific**.**	?
	• Migration hazards (Collisions, electrocution**,** *human direct killing***,** *human incidental killing* **–** out-of basin-factors)**.**	U

1/ 1 = low, 2 = moderate, 3 = high, U = unknown

Table 19 . Changes in quantities (acres) of habitat types in the Columbia River Gorge, ca 1850 - Present, based on IBIS.

	Period		
Habitat Name	Historic	Present	Change
Mesic Lowlands Conifer-Hardwood Forest	79,010	111,160	246%
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Westside Riparian-Wetlands	3,470	0	-100%
Desert Playa and Salt Scrub Shrublands	2,650	0	-100%
Western Juniper and Mountain Mahogany Woodlands	740	0	-100%
Herbaceous Wetlands	560	50	-110%
Lodgepole Pine Forest and Woodlands	470	0	-100%
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Bays and Estuaries	0	40	0%
Montane Coniferous Wetlands	0	70	0%
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Westside Oak and Dry Douglas-fir Forest and Woodlands	0	4,110	0%
Grand Total	307,450	307,450	

Table 20. Current wildlife habitat types by area (acres) and land ownership in the Columbia Gorge subbasin.

Habitat type	Federal	Tribal	State	Local government	Non-governmental organizations	Private	Water	Total
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Interior Grasslands	1,110	0	1,221	36	144	25,078	0	27,589
Shrub-steppe	1,472	264	628	401	0	23,087	0	25,852
Interior Mixed Conifer Forest	10,306	130	205	17	18	11,957	0	22,633
Lakes, Rivers, Ponds, and Reservoirs	227	5	220	0	0	1,551	18,464	20,467
Agriculture, Pasture, and Mixed Environs	26	1	66	100	0	13,592	0	13,785
Montane Mixed Conifer Forest	8,484	0	144	2	0	104	0	8,734
Urban and Mixed Environs	109	2	2	0	0	6,977	0	7,090
Westside Oak and Dry Douglas-fir Forest & Woodlands	480	11	6	0	17	3,602	0	4,116
Montane Coniferous Wetlands	27	0	34	0	0	148	0	209
Herbaceous Wetlands	0	0	0	0	0	65	0	65
Interior Riparian Wetlands	2	0	9	0	0	19	29	59
Bays and Estuaries	0	0	0	0	0	7	35	42
Alpine Grasslands and Shrublands	7	0	0	0	0	0	0	7
Total	83,561	602	25,589	1,758	352	177,052	18,528	307,442

Source: IBIS, URL *http://nwhi.org/ibis/subbasin/subs2.asp*

8 Figures

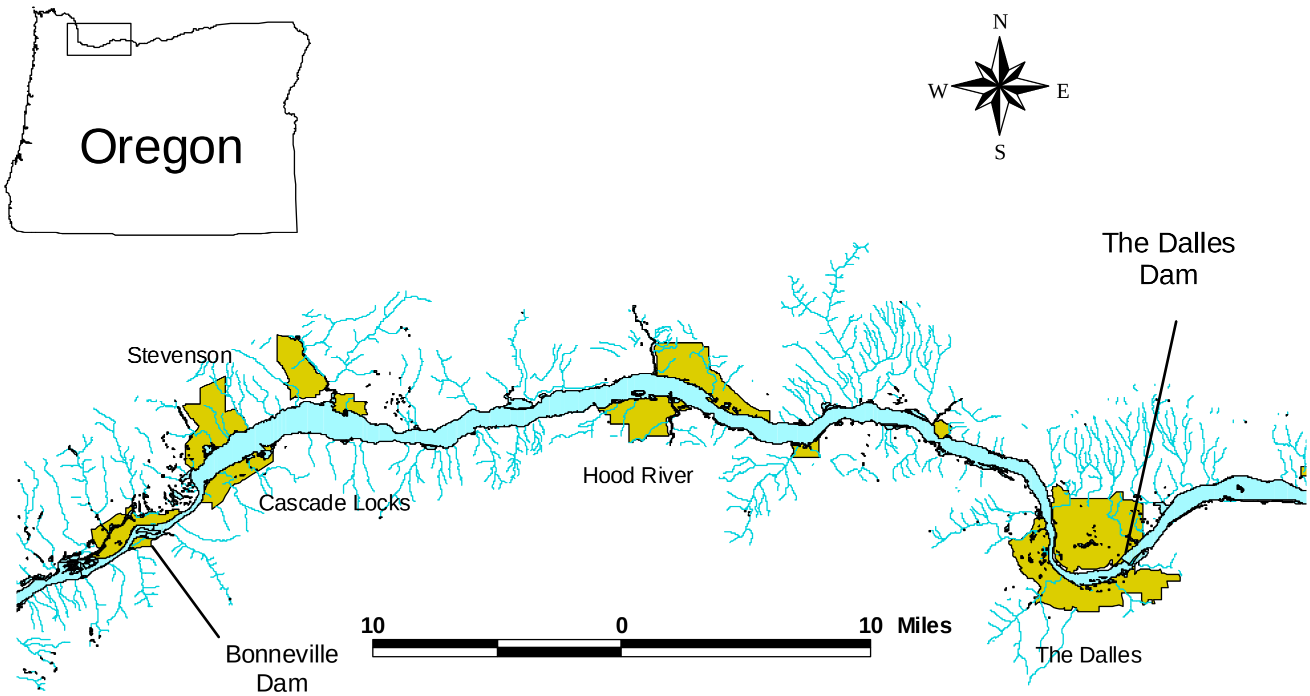


Figure 1. Location of Columbia Gorge Subbasin Planning Area.

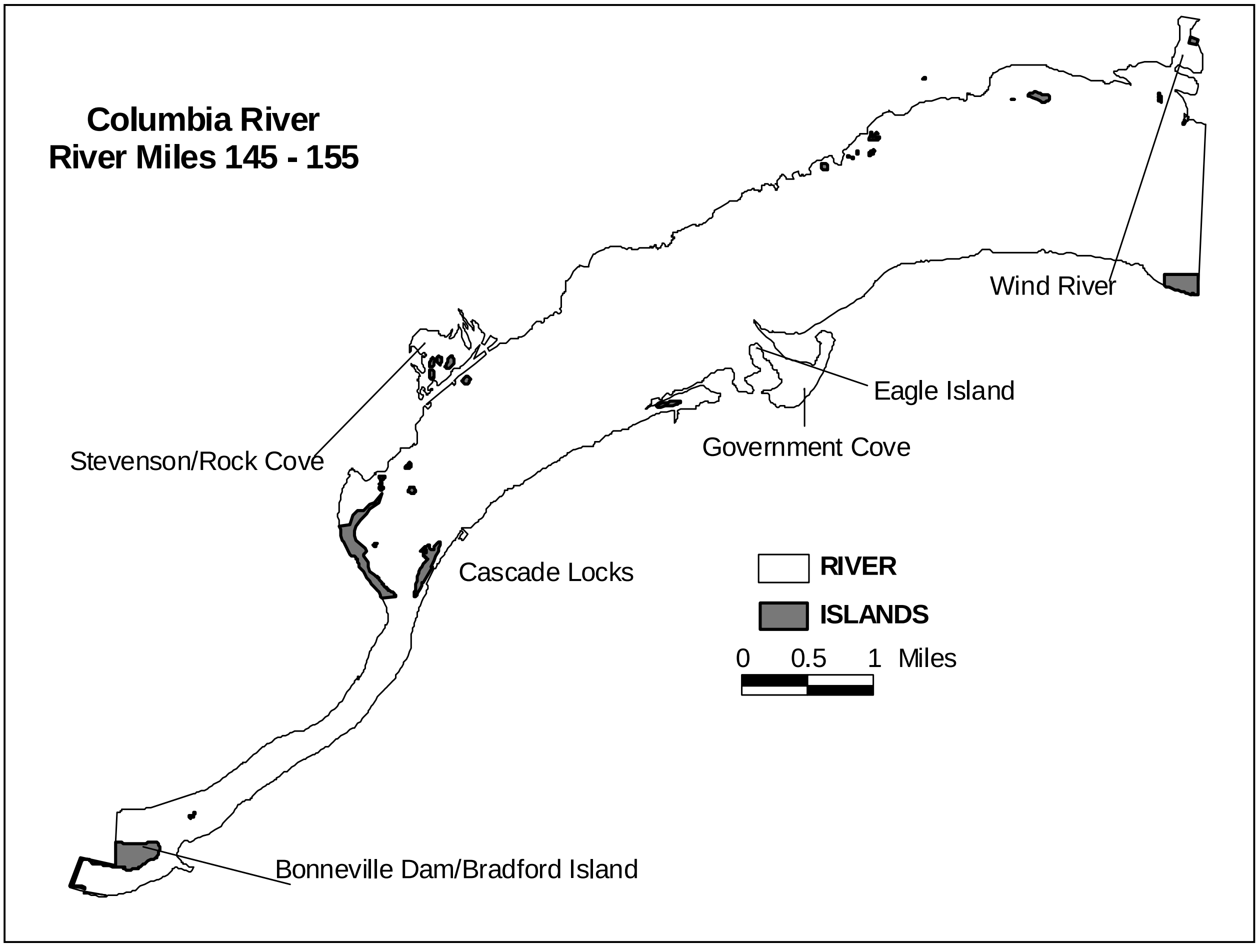


Figure 2. Location of islands within Bonneville Reservoir by river mile, 145 – 155.

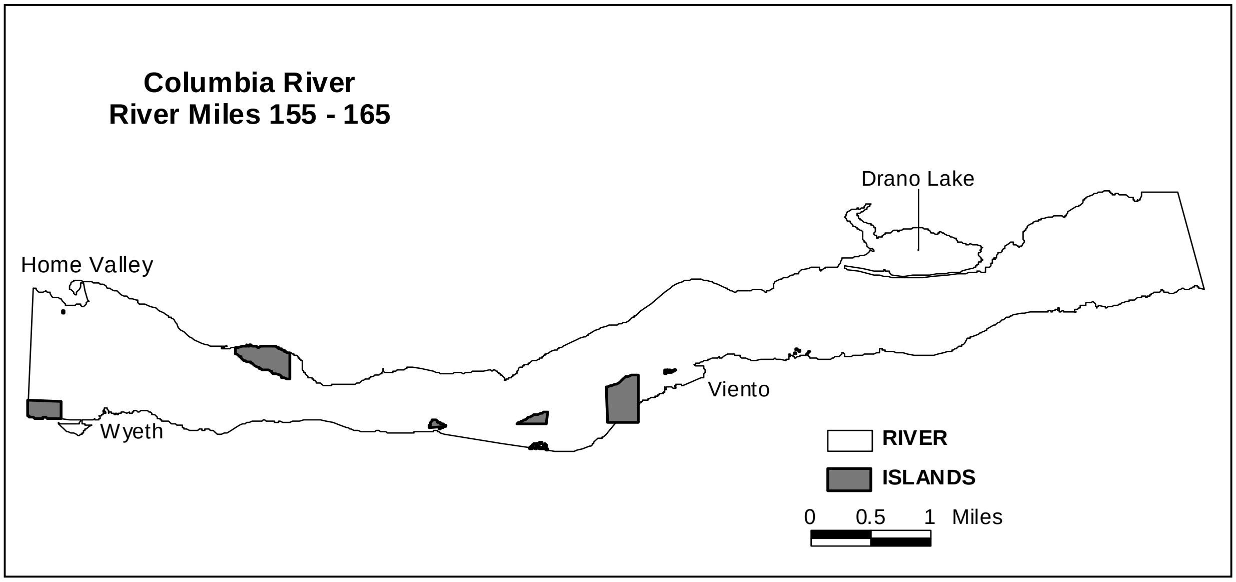


Figure 3. Location of islands within Bonneville Reservoir by river mile, 155 – 165.

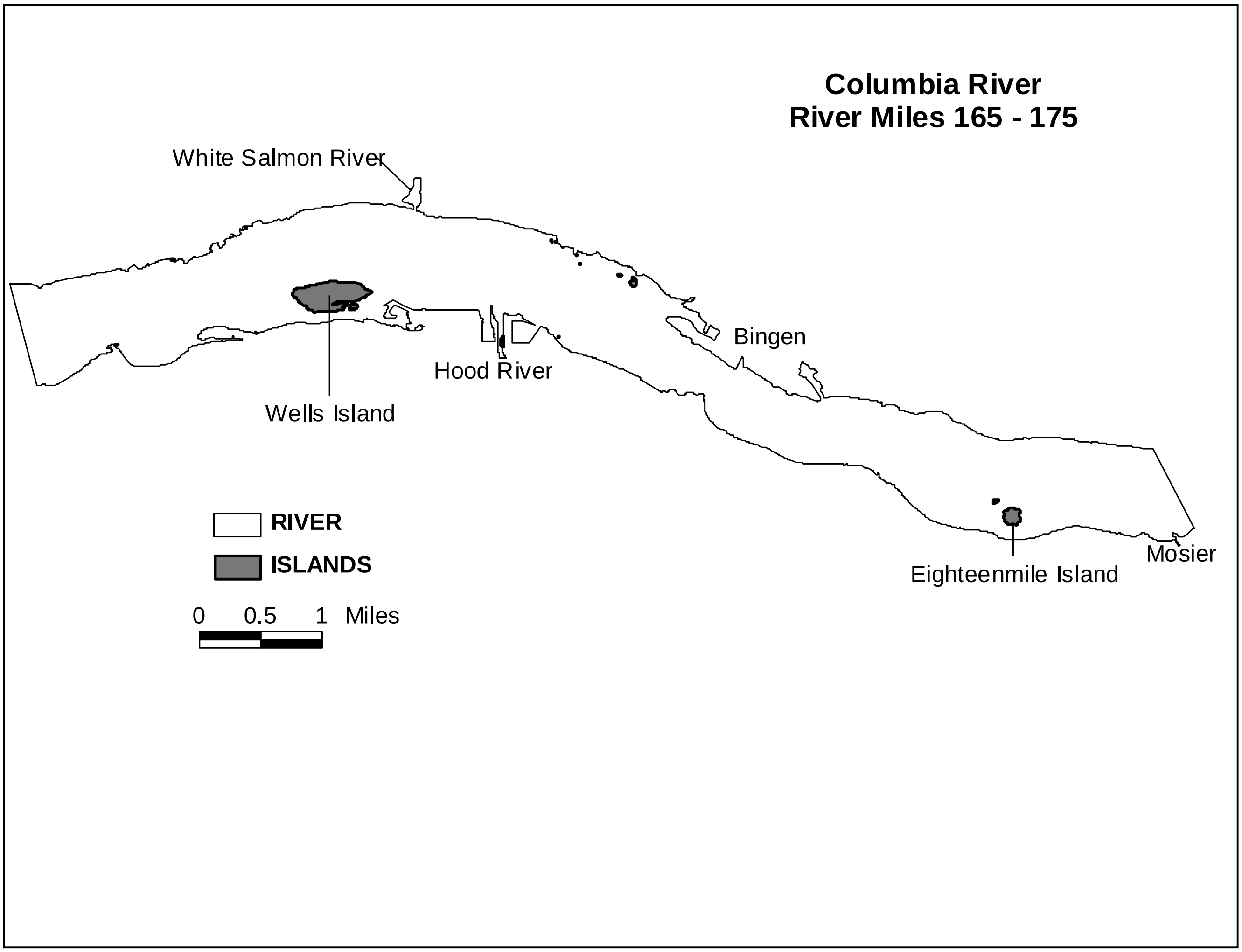


Figure 4. Location of islands within Bonneville Reservoir by river mile, 165 – 175.

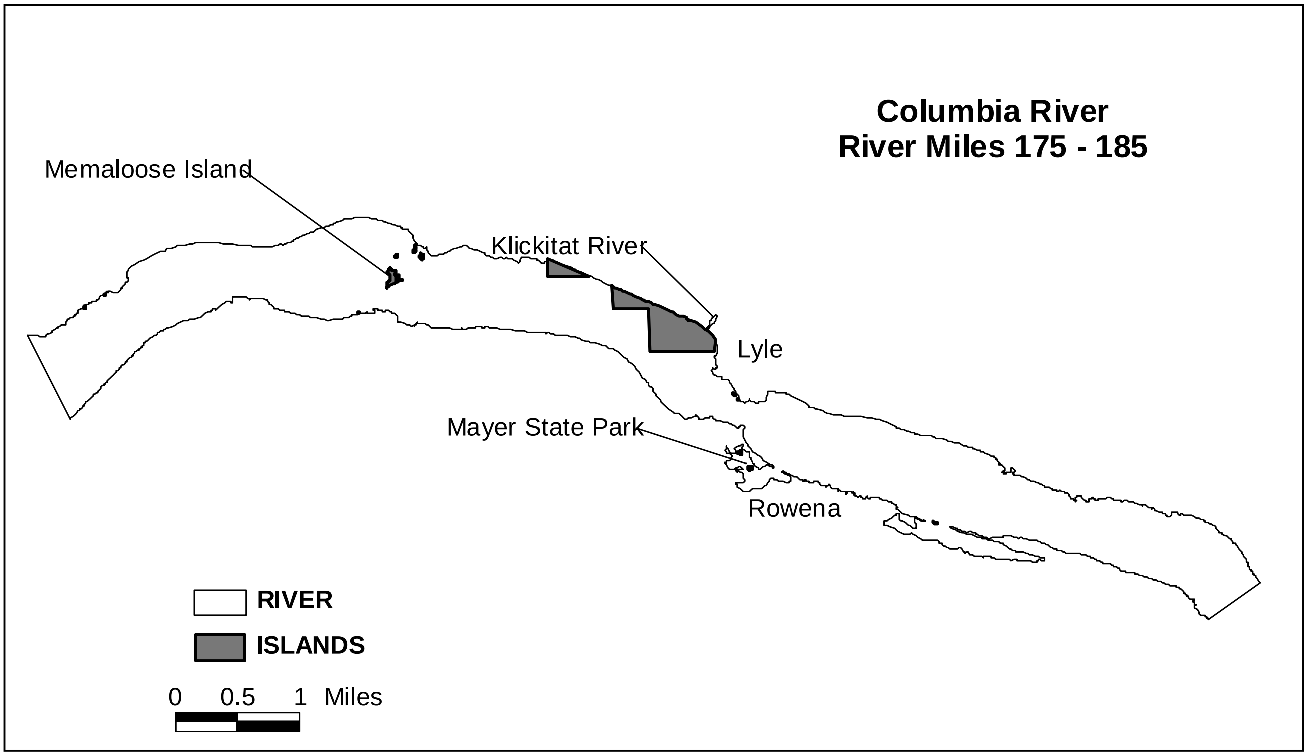


Figure 5. Location of islands within Bonneville Reservoir by river mile, 175 – 185.

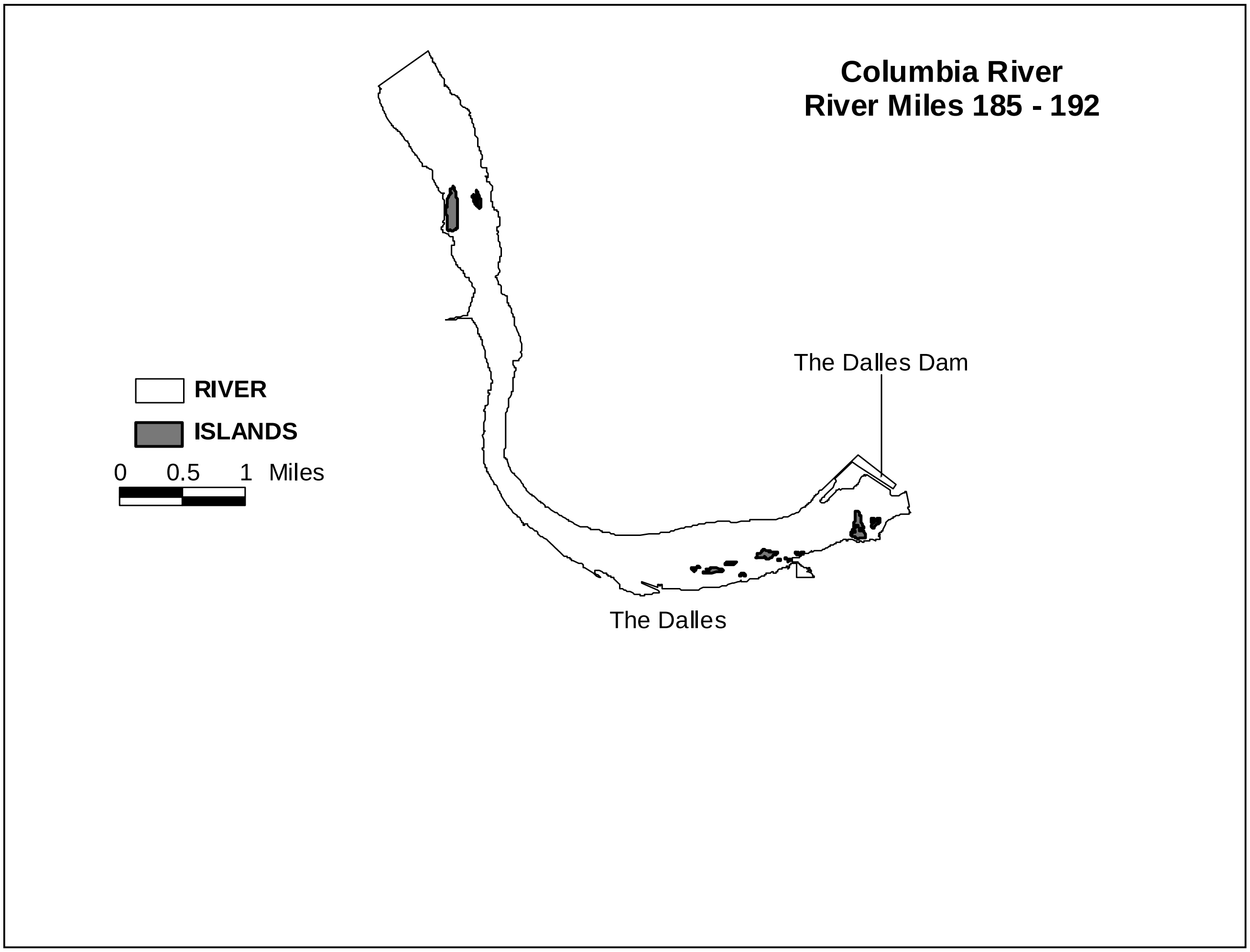


Figure 6. Location of islands within Bonneville Reservoir by river mile, 185 – 192.

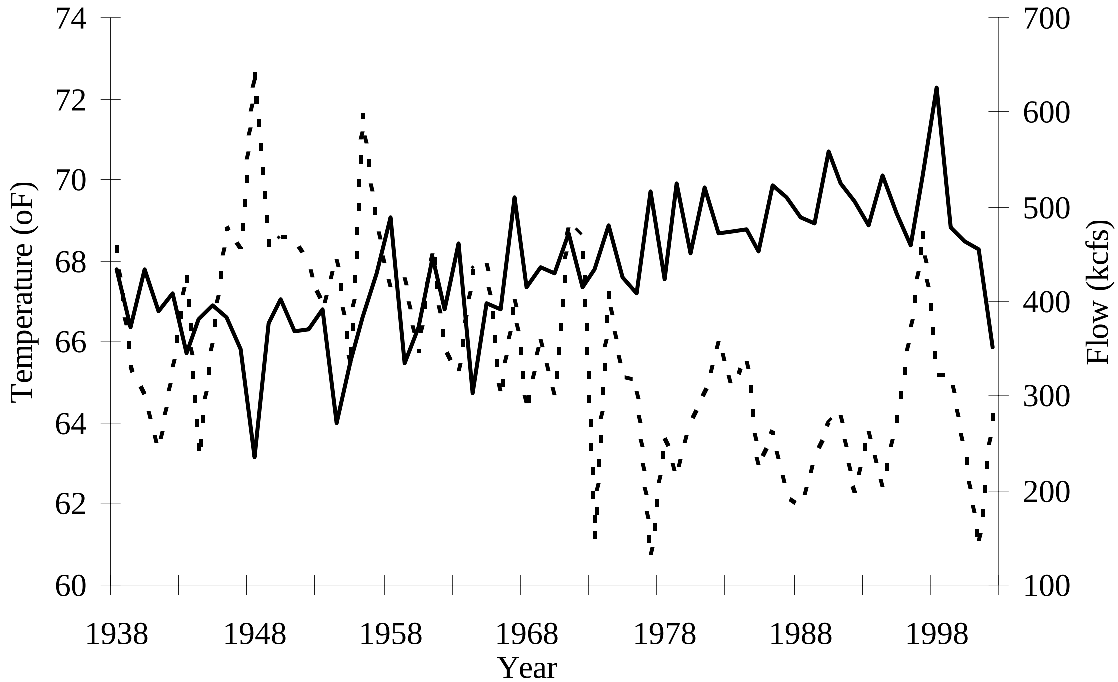


Figure 7. Average daily water temperature August through September (solid line) and flow May through June (dashed line) at Bonneville Dam by year.

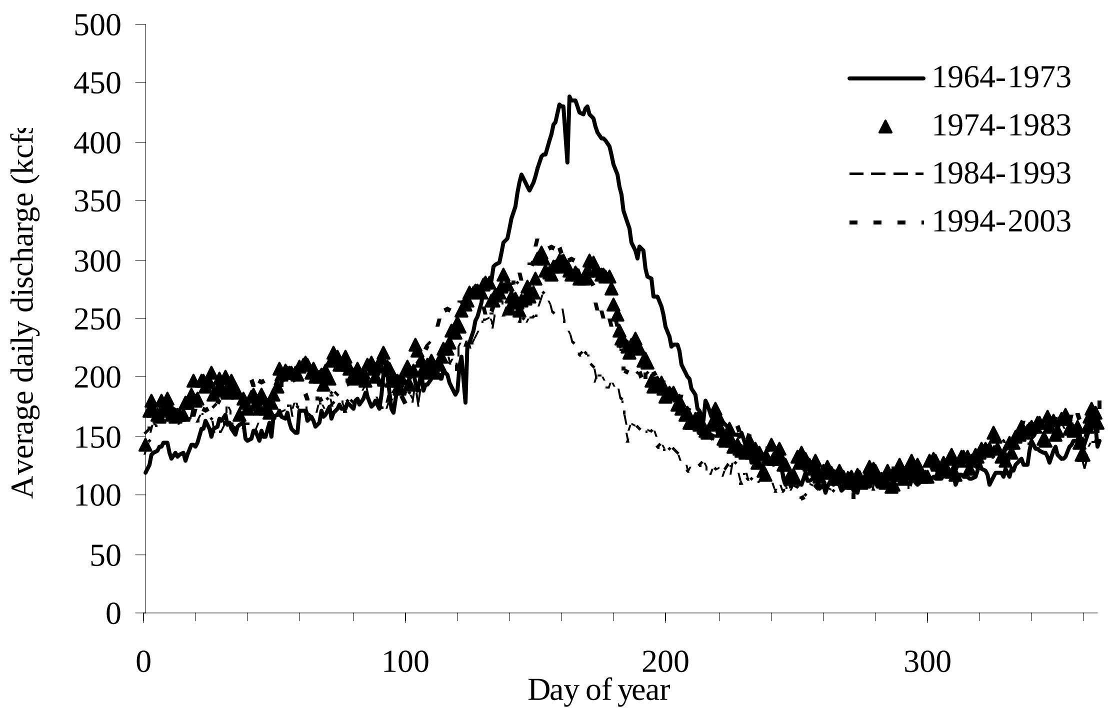


Figure 8. Average daily discharge at the The Dalles Dam by decade, 1964-2003.

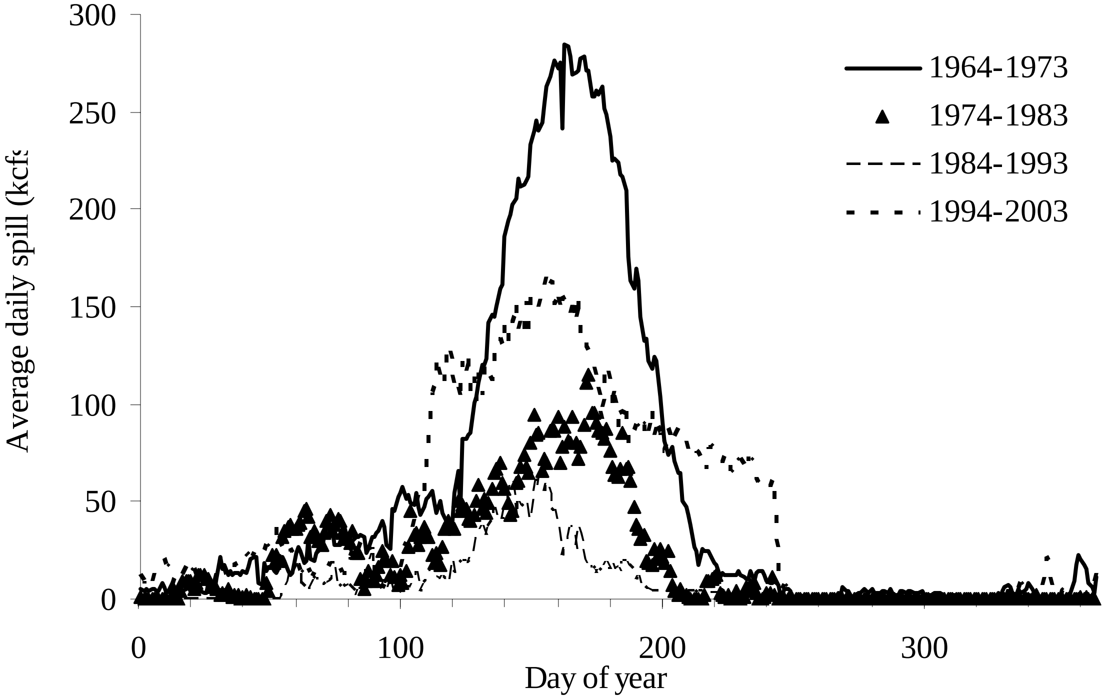


Figure 9. Average daily spill at The Dalles Dam by decade, 1964-2003.

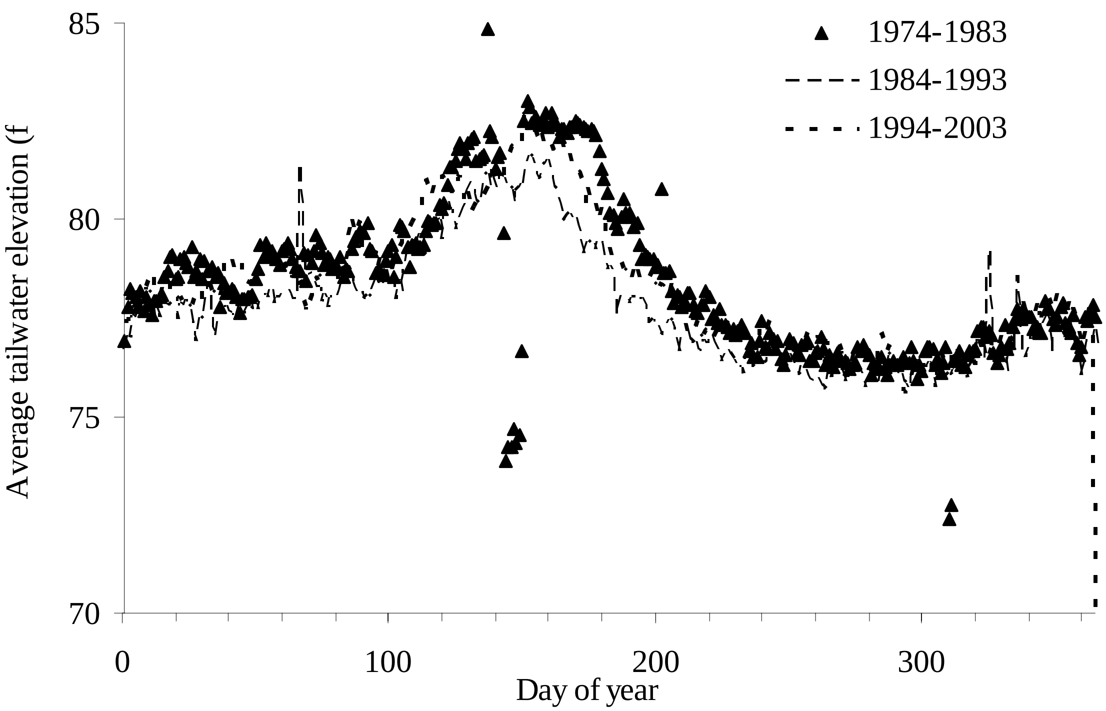


Figure 10. Average daily tailwater elevation at The Dalles Dam, 1974-2003.

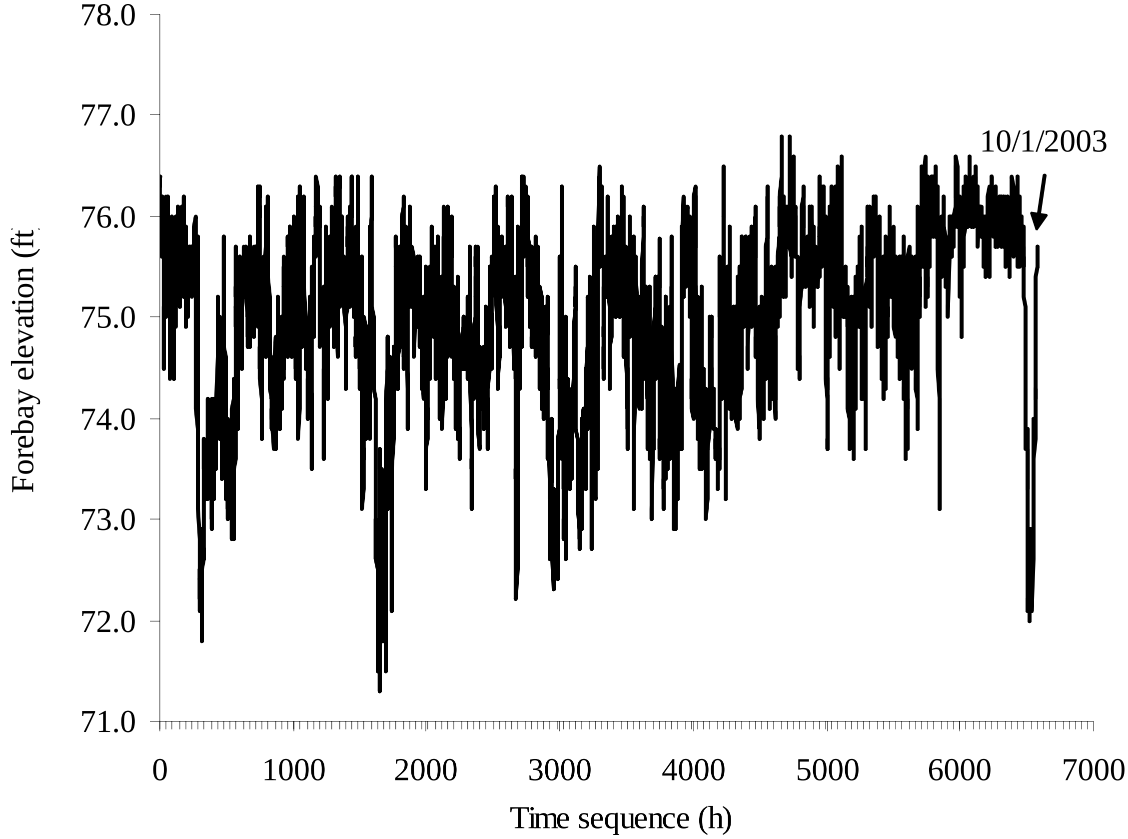


Figure 11. Average hourly surface elevation in Bonneville Dam forebay during 2003.

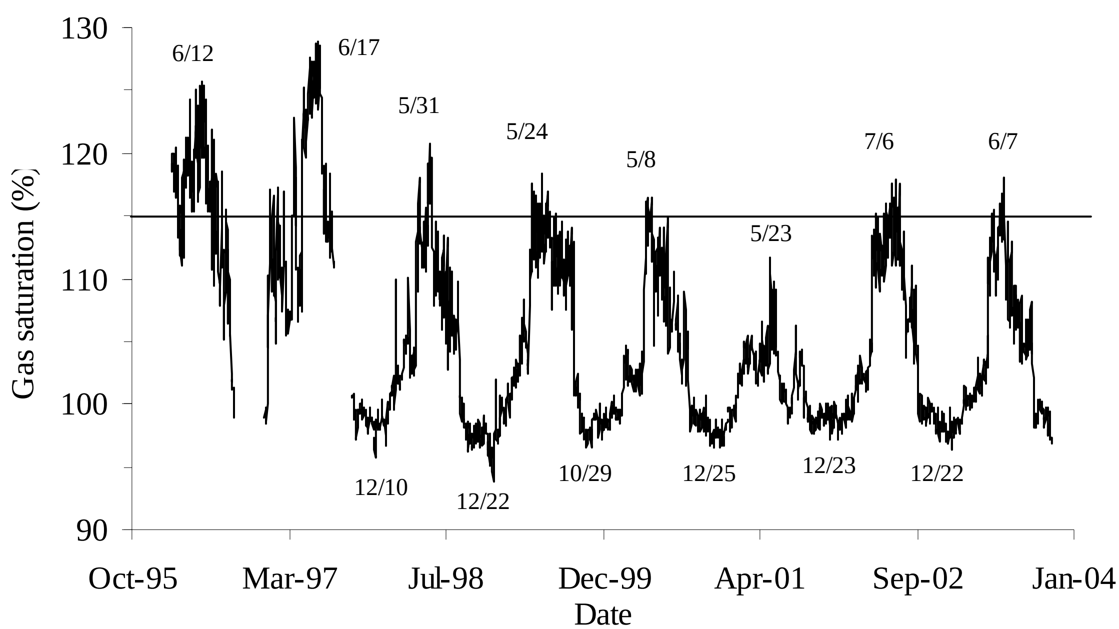


Figure 12. Daily total dissolved gas (% saturation) at Bonneville Dam forebay, 1996-2003.

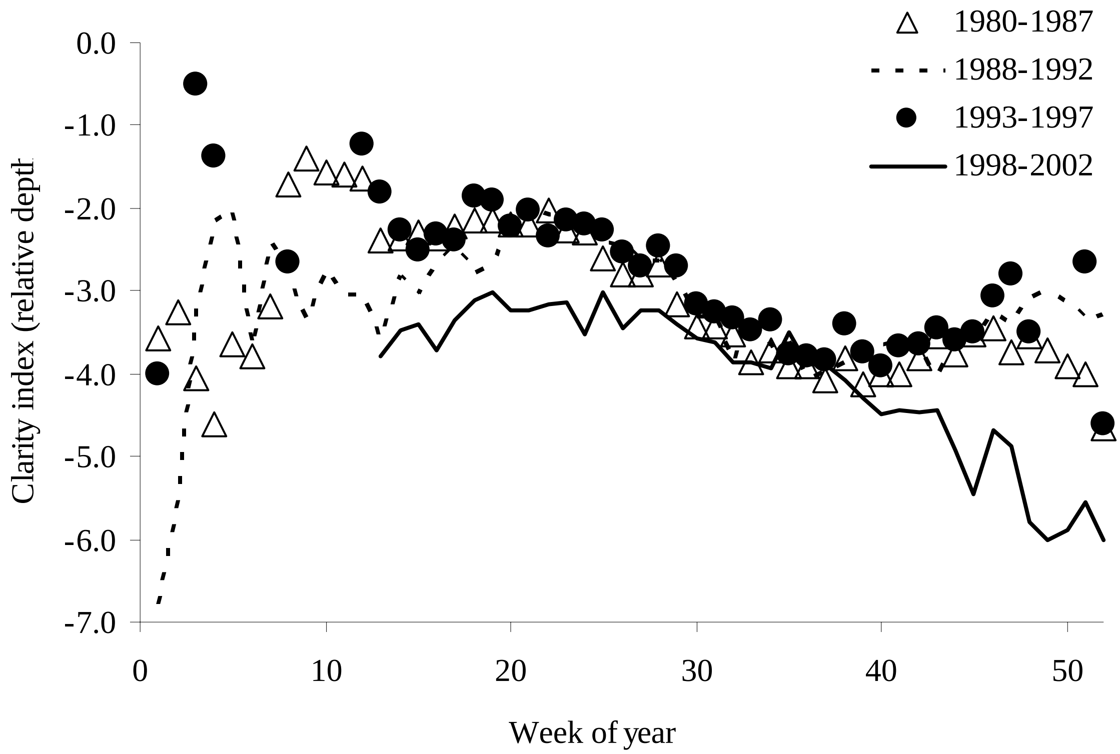
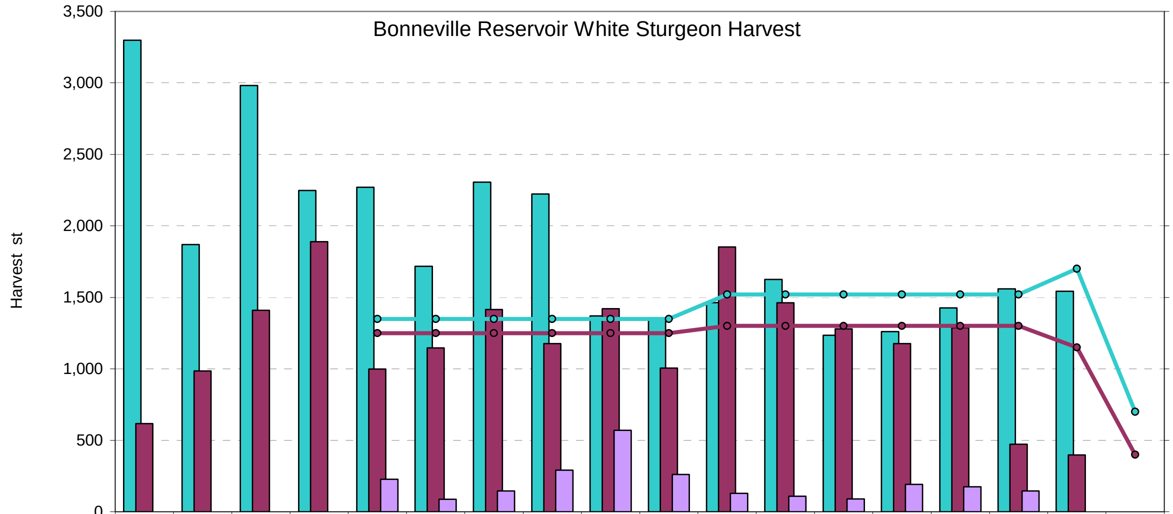


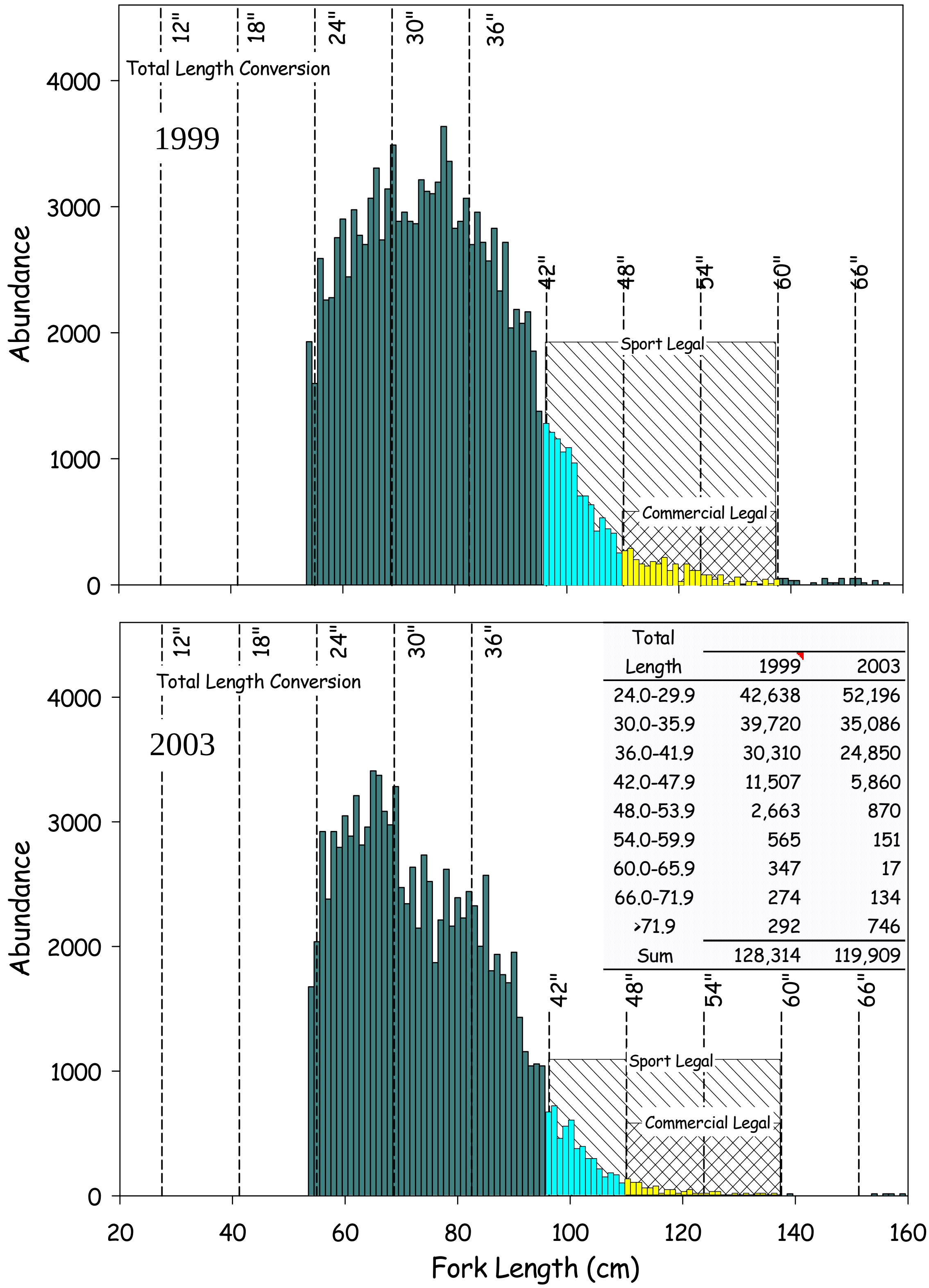
Figure 13. Index of water clarity by week in The Dalles Dam tailrace, 1980 – 2002.



	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Recreational	3,300	1,870	2,982	2,249	2,270	1,717	2,307	2,223	1,370	1,353	1,463	1,626	1,235	1,262	1,426	1,560	1,542	
Commercial	618	985	1,410	1,890	999	1,146	1,415	1,176	1,421	1,005	1,852	1,462	1,280	1,177	1,287	472	398	
Subsistence					227	89	146	290	570	260	130	109	90	191	174	146		
Rec guideline					1,350	1,350	1,350	1,350	1,350	1,350	1,520	1,520	1,520	1,520	1,520	1,520	1,700	700
Com Guideline					1,250	1,250	1,250	1,250	1,250	1,250	1,300	1,300	1,300	1,300	1,300	1,300	1,150	400

Year

Figure 14. White sturgeon harvest in sport, Tribal commercial, and Tribal subsistence fisheries, Bonneville Reservoir 1987-2004.



Total Length	1999	2003
24.0-29.9	42,638	52,196
30.0-35.9	39,720	35,086
36.0-41.9	30,310	24,850
42.0-47.9	11,507	5,860
48.0-53.9	2,663	870
54.0-59.9	565	151
60.0-65.9	347	17
66.0-71.9	274	134
>71.9	292	746
Sum	128,314	119,909

Figure 15. Estimated abundance and fork length distribution of white sturgeon in Bonneville Reservoir, 1999 and 2003.

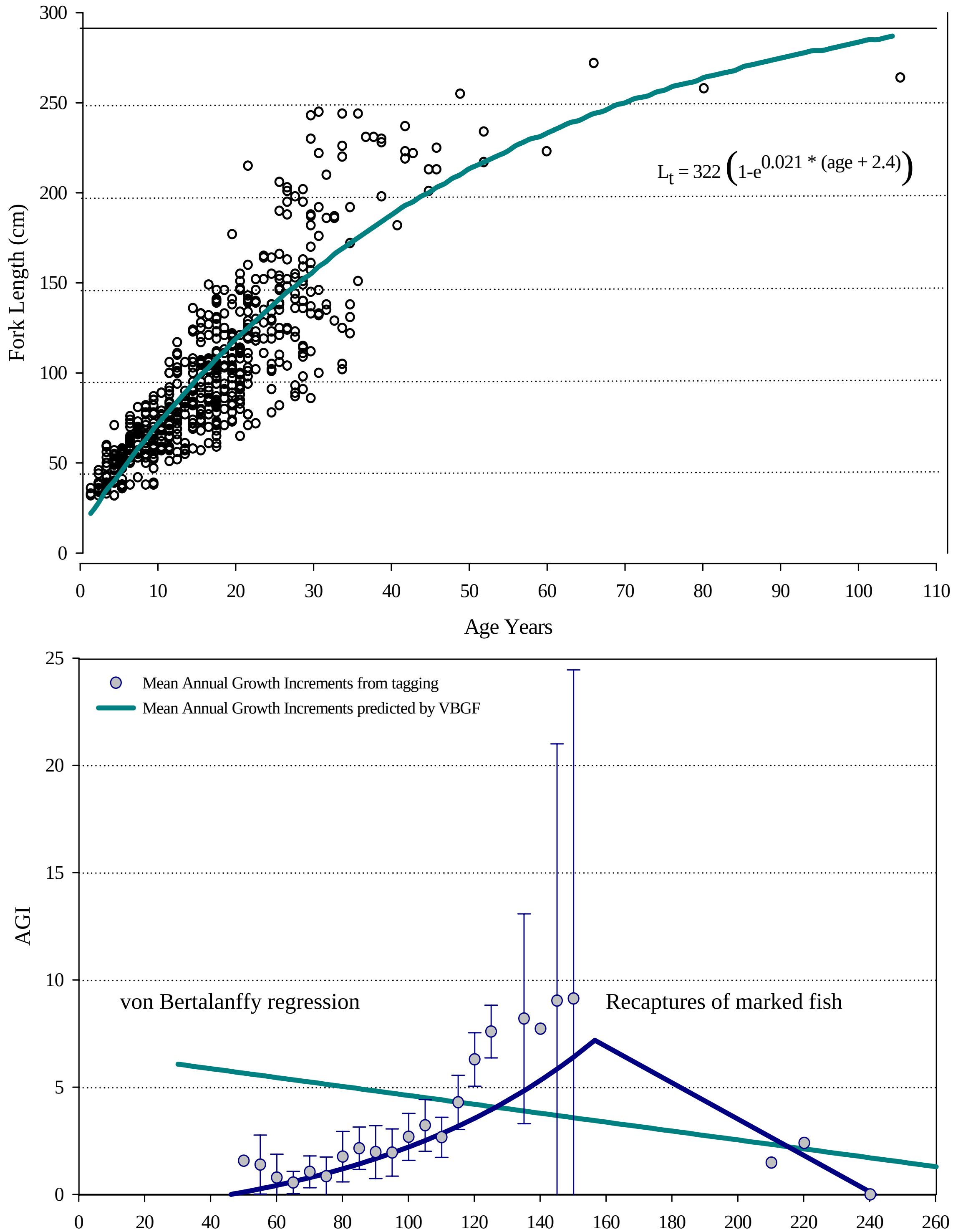


Figure 16. Fork length and age interpreted from pectoral fin-spine annuli white sturgeon and von Bertalanffy regression (top). Annual growth increment (AGI) by fork length based on von Bertalanffy regression and observed from recaptures of marked fish (bottom).

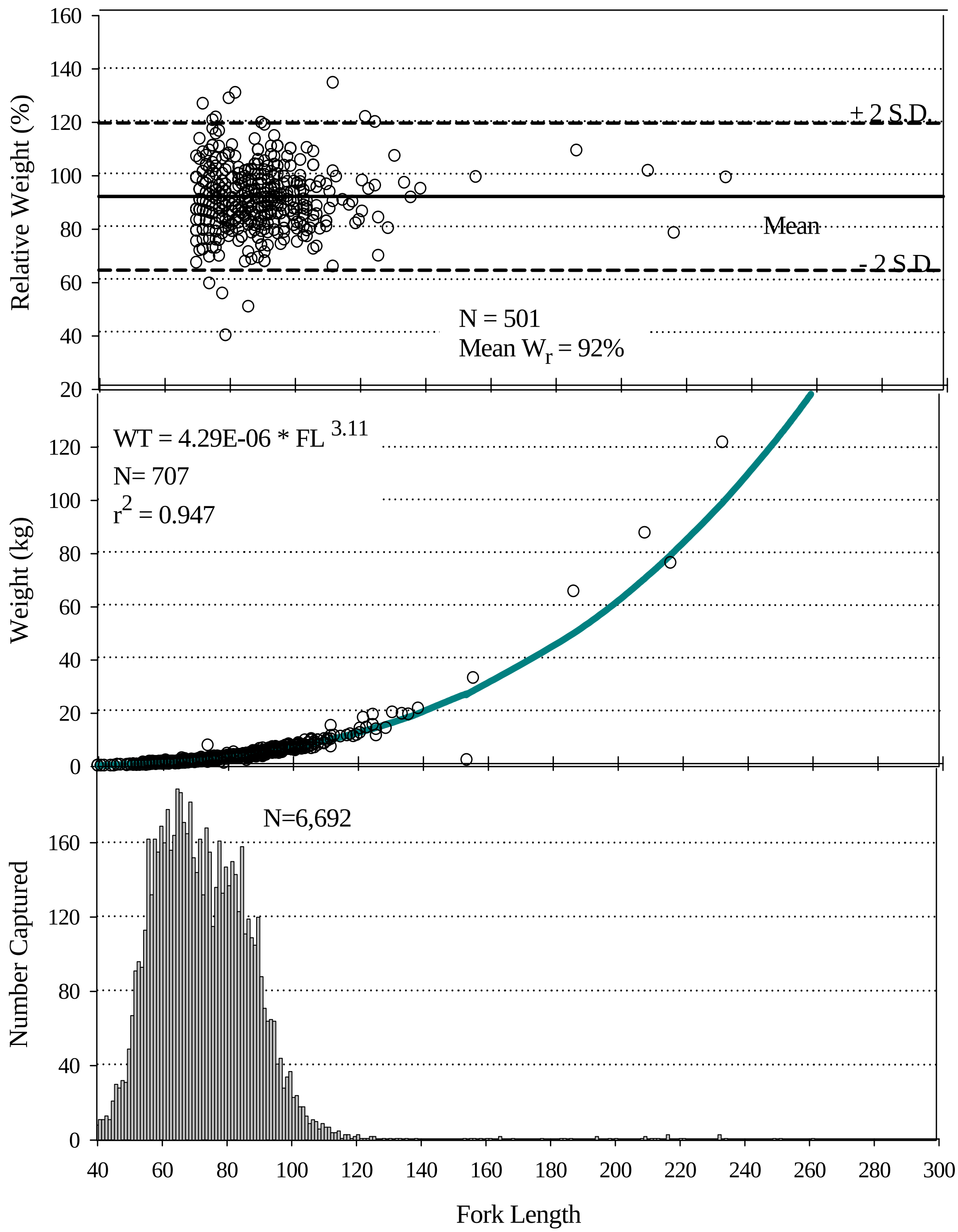


Figure 17. Relative weight, weight at length and length frequency of setline catches for white sturgeon captures in Bonneville Reservoir, 2003.

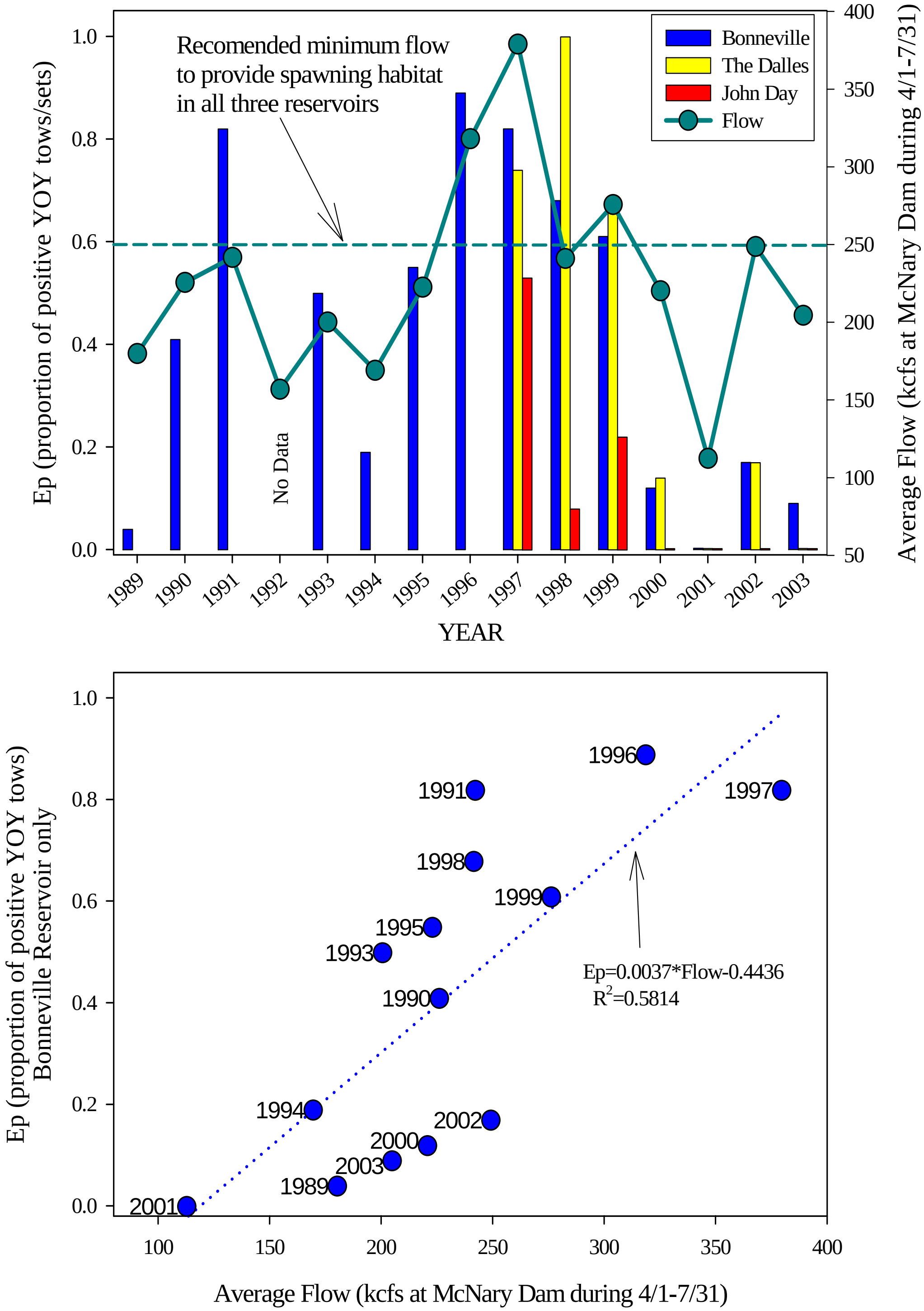


Figure 18. Recruitment index for white sturgeon (proportion of sets capturing one or more young-of-year fish) in Bonneville, The Dalles, and John Day reservoirs, and average daily flow at McNary Dam (April-July). The Bonneville index is based on standardized trawl efforts 1989-2003. The Dalles and John Day indexes are based on standardized gill-net effort initiated in 1997. All information is preliminary.

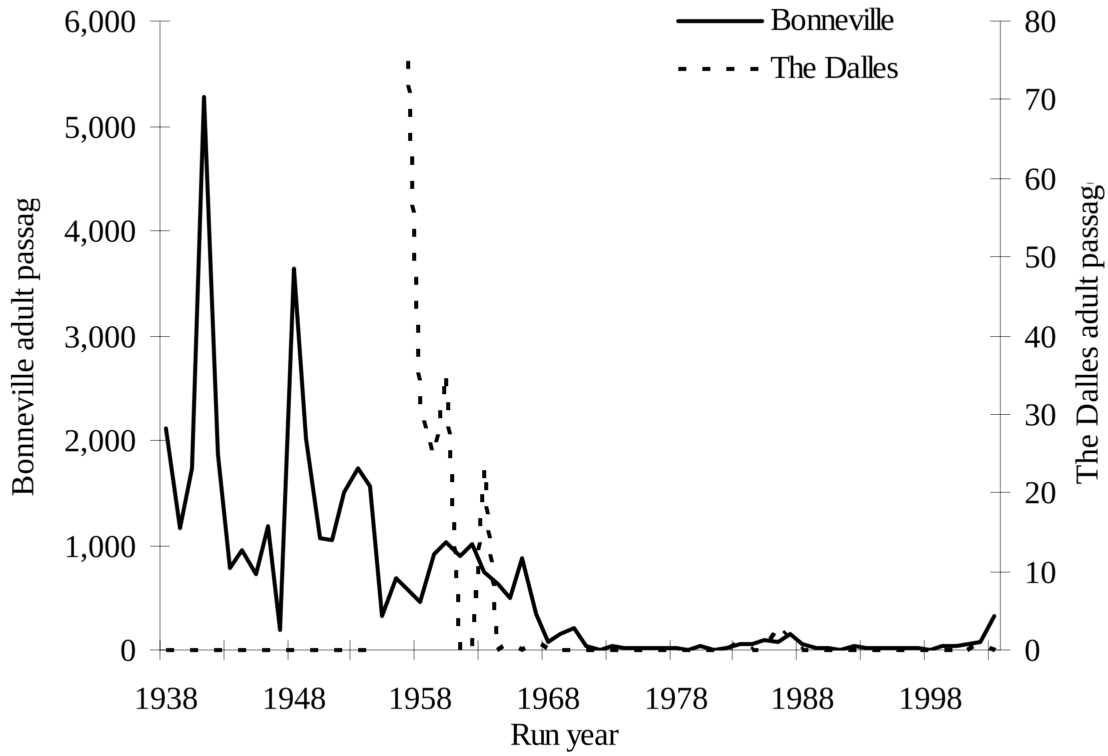


Figure 19. Counts of upstream passage of adult chum salmon at Bonneville and The Dalles dams, 1938 - 2003

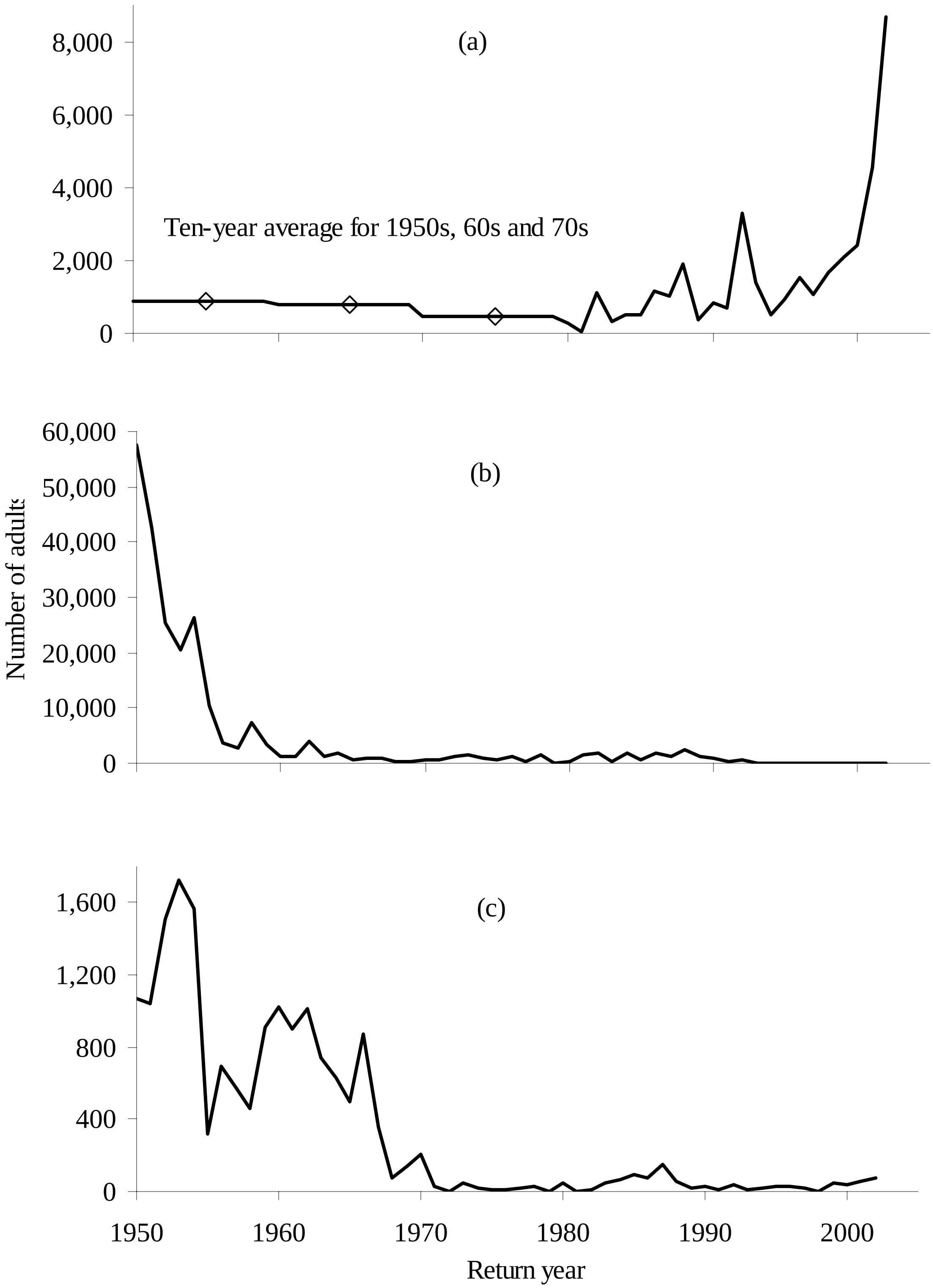


Figure 20. Trends in numbers of chum salmon in the lower Columbia River. (a) Index of escapement to Washington tributaries downstream of Bonneville Dam; (b) Commercial harvest downstream of Bonneville Dam; (c) Counts of adult passage at Bonneville Dam.

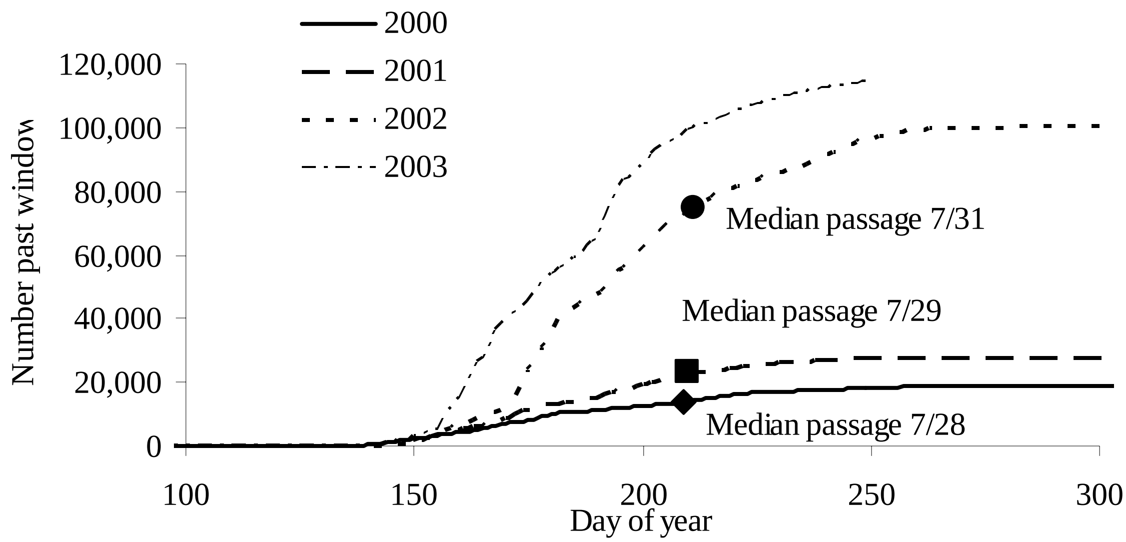


Figure 21. Passage counts of adult Pacific lamprey at Bonneville Dam.

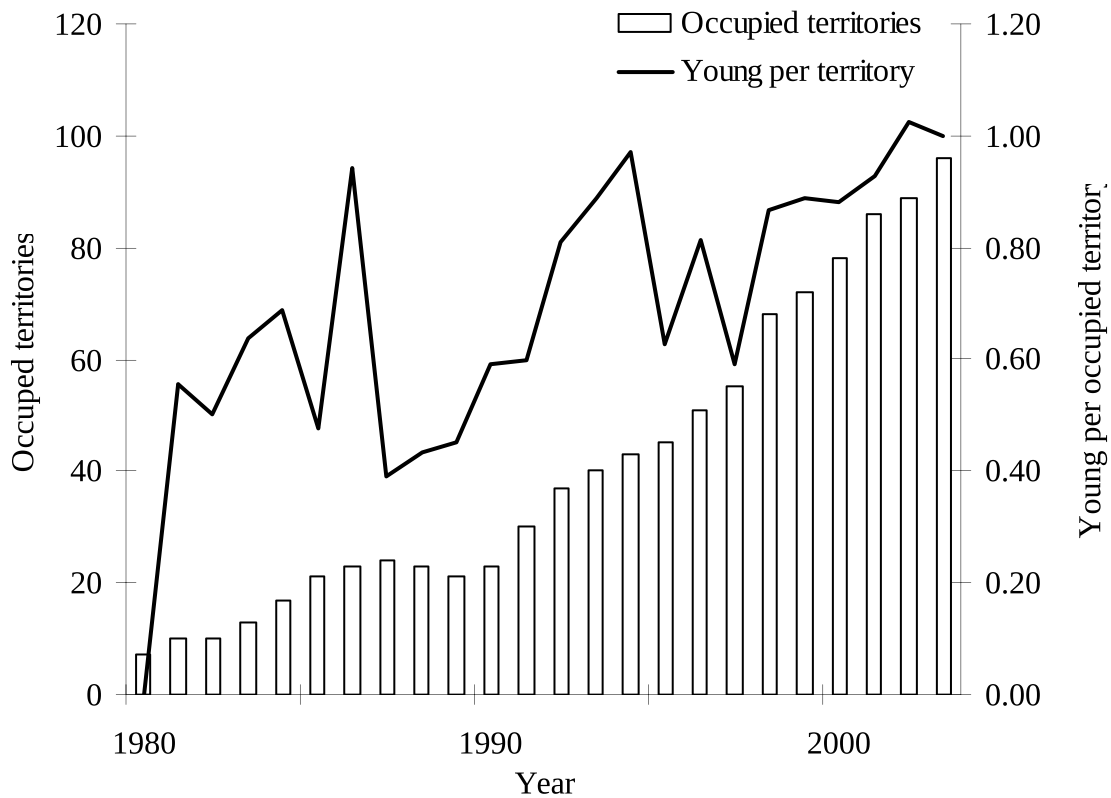


Figure 22. Number of bald eagle occupied breeding territories and productivity rate in the Columbia River Recovery Zone (Zone 10; adapted from Isaacs and Anthony, 2003).