7 Aquatic Resources

7.1 Fish Habitat Areas and Quality

7.1.1 Anadromous Species

Due to the significant loss of mainstem habitat, function, and direct and indirect mortalities associated with the Federal Columbia River hydropower system (FCRPS), tributary habitat has become more critical to the survival and recovery of listed anadromous species throughout the Columbia Basin. Due to direct and indirect effects of the FCRPS, NOAA Fisheries has directed in its ESA 2000 BIOP that tributary habitat improvements are required as part of off-site mitigation activities of the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and the Bonneville Power Administration for continued operation. The potential for habitat-based off-site mitigation within the Clearwater subbasin is affected by the Dworshak Dam blockage of the North Fork Clearwater River system, and by expanses of pristine habitats in wilderness and other protected areas.

In the Clearwater subbasin, steelhead trout and fall chinook salmon are listed as threatened under the Endangered Species Act (ESA) and have had critical habitats designated by NOAA Fisheries. Spring chinook salmon within the Clearwater subbasin have been excluded from the ESA listing for Snake River spring/summer chinook and therefore have no designated critical habitat areas. While subpopulations of spring chinook salmon are distributed throughout the subbasin, they are not listed under the ESA because the current natural runs are primarily the result of the past reintroduction programs (NPT and IDFG 1990; Columbia River Inter-Tribal Fish Commission 2000). Critical habitat as defined by NOAA Fisheries includes all waterways, substrate and adjacent riparian zones below longstanding, naturally impassable barriers. Riparian zones are defined as those areas within a horizontal distance of 300 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water. Indian lands are excluded from designated critical habitats.

For steelhead trout, critical habitat within the Clearwater subbasin includes all accessible river reaches, and excludes areas above Dworshak Dam and any longstanding, naturally impassable barriers in existence for at least several hundred years. Current documentation of naturally impassable barriers is lacking. Attempts have been made to document natural barriers (Murphy and Metsker 1962), but incomplete records and subsequent modification or elimination of many barriers has precluded documentation of those that currently exist.

Designated critical habitat within the Clearwater subbasin for fall chinook salmon includes the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek, the North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam, and all other river reaches presently or historically accessible to fall chinook salmon in the Lower Clearwater and Lower North Fork Clearwater (below Dworshak Dam) AUs.

Habitat quality for spring chinook salmon and steelhead trout was estimated in a relatively comprehensive manner throughout the subbasin during development of the Northwest Power Planning Council Presence/Absence Database. Habitat quality ratings were compiled by stream reach and are qualitative and species specific. Habitat quality for each species was rated as excellent, good, fair or poor. For the purposes of this assessment, NPPC stream reach ratings of habitat quality were subsequently summarized within each applicable 6^{th} field HUC by assigning numerical values to each rating, and calculating the weighted average for each HUC using segment length as the weighting variable.

Very little habitat within the Clearwater subbasin has been defined as excellent for spring chinook salmon. Excellent habitat is typically limited to the highest elevation headwater streams within the Lochsa and Upper Selway AUs (Figure 96). However, if not blocked by Dworshak Dam, the Upper and Lower North Fork AUs would provide substantial amounts of excellent spring chinook habitat (Mallett 1974). The USFWS (1962) found that headwater streams in the North Fork Clearwater subbasin, prior to blockage by Dworshak Dam, provided excellent spawning and rearing habitat for anadromous fish, including spring chinook salmon. Good and fair spring chinook salmon habitat is widely intermixed and found throughout the majority of the usable mainstem and tributary reaches of the Lochsa, South Fork, and Upper and Lower Selway AUs. Poor habitat conditions for spring chinook are typically associated with lower mainstem reaches of major tributaries (Lolo Creek, Lochsa, Selway and South Fork Clearwater Rivers) and the mainstem Clearwater River.

Prior to blockage by Dworshak Dam, habitat in the North Fork Clearwater provided excellent steelhead spawning and rearing habitat that supported 60% of the spawning activity in the Clearwater subbasin (USFWS 1962). Of the remaining habitat in the subbasin, excellent steelhead trout habitat characterizes the vast majority of the available habitat in the Upper Selway AU, and the majority of tributary habitats within the Lower Selway and Lochsa AUs (Figure 97). The mainstem Lochsa River and mainstem Selway River above the wilderness boundary provide ‘good’ steelhead trout habitat, as do most of the tributary systems within the South Fork AU. Within the South Fork AU, ‘excellent’ steelhead trout habitat is associated with drainages originating within the Gospel Hump Wilderness Area: Johns Creek, Tenmile Creek, and the uppermost reaches of Crooked River. The Lower Clearwater and Lolo/Middle Fork AUs are most typically characterized by fair to poor steelhead habitat throughout. Notable exceptions are Big Canyon Creek and portions of Lolo Creek which are characterized as “good” steelhead trout habitat.

7.1.2 Resident Species

Bull trout have more specific habitat requirements than other salmonids. Strong bull trout populations are associated with a high degree of channel complexity, including woody debris and substrate with clear interstitial spaces. The amount of habitat complexity or cover required to maintain strong bull trout population(s) cannot however, be quantified (Batt 1996).

Temperature is a critical habitat element for bull trout, which may experience considerable stress in temperatures over 15°C (1992 cited in Clearwater subbasin Bull Trout Technical Advisory Team 1998a; Batt 1996). Optimum temperatures for incubation and rearing have been cited between 2 and 4°C and 7 and 8°C, respectively (Rieman and McIntyre 1993). Other habitat parameters of particular importance to bull trout populations include channel stability, substrate composition, cover, and migratory corridors (Rieman and McIntyre 1993).

Ten bull trout key watersheds within the Clearwater subbasin were defined in the State of Idaho Bull Trout Conservation Plan (Batt 1996) based in part on the following habitat characteristics: key watersheds must provide all critical bull trout habitat elements and are selected from the best available habitat with the best opportunity to be restored to high quality. Key watersheds defined for bull trout within the Clearwater subbasin are summarized in Table 54 and Figure 106.

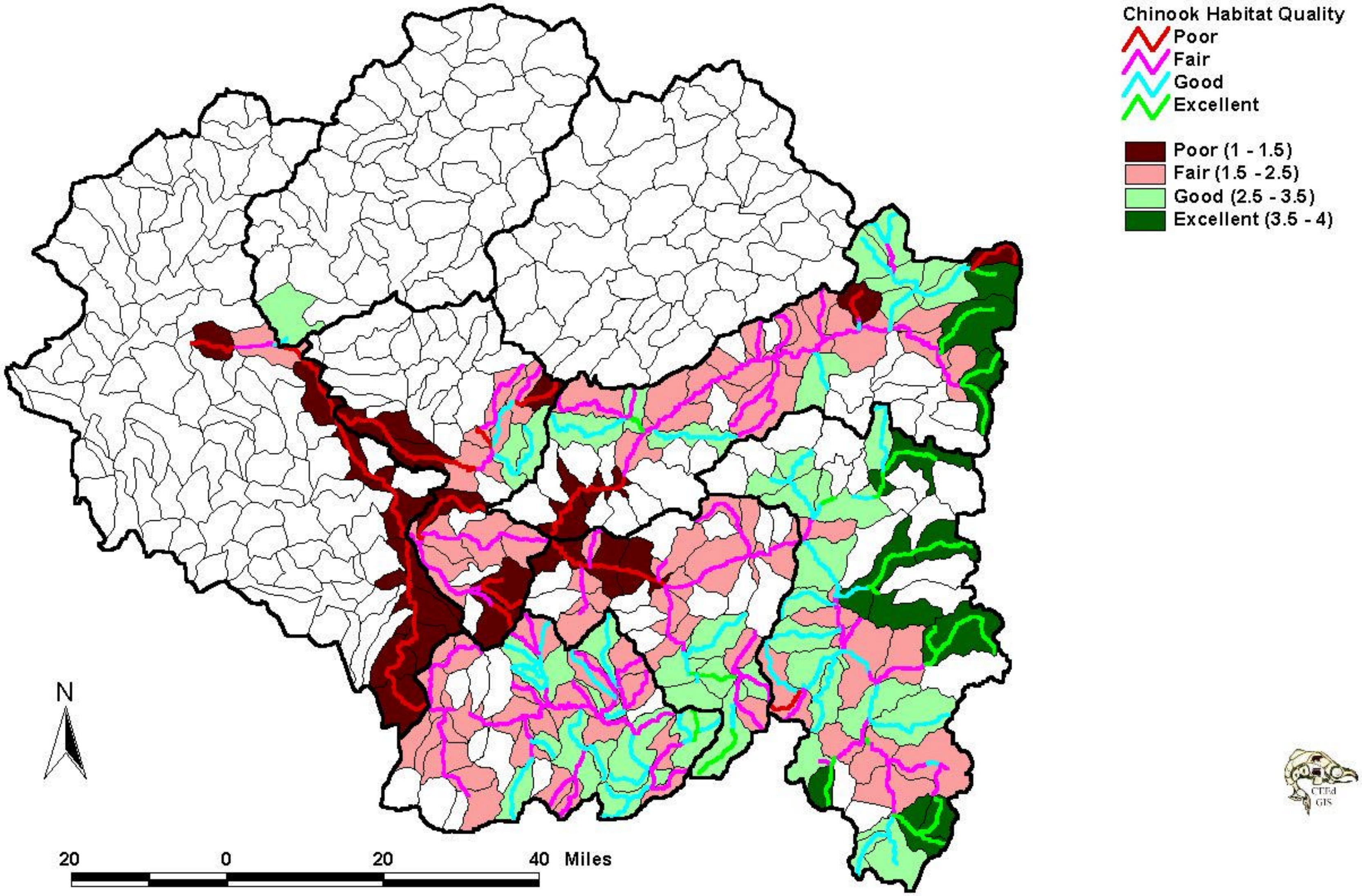

Figure 96. Habitat quality for spring chinook salmon as defined by NPPC's presence absence database (stream reaches) summarized by subwatershed

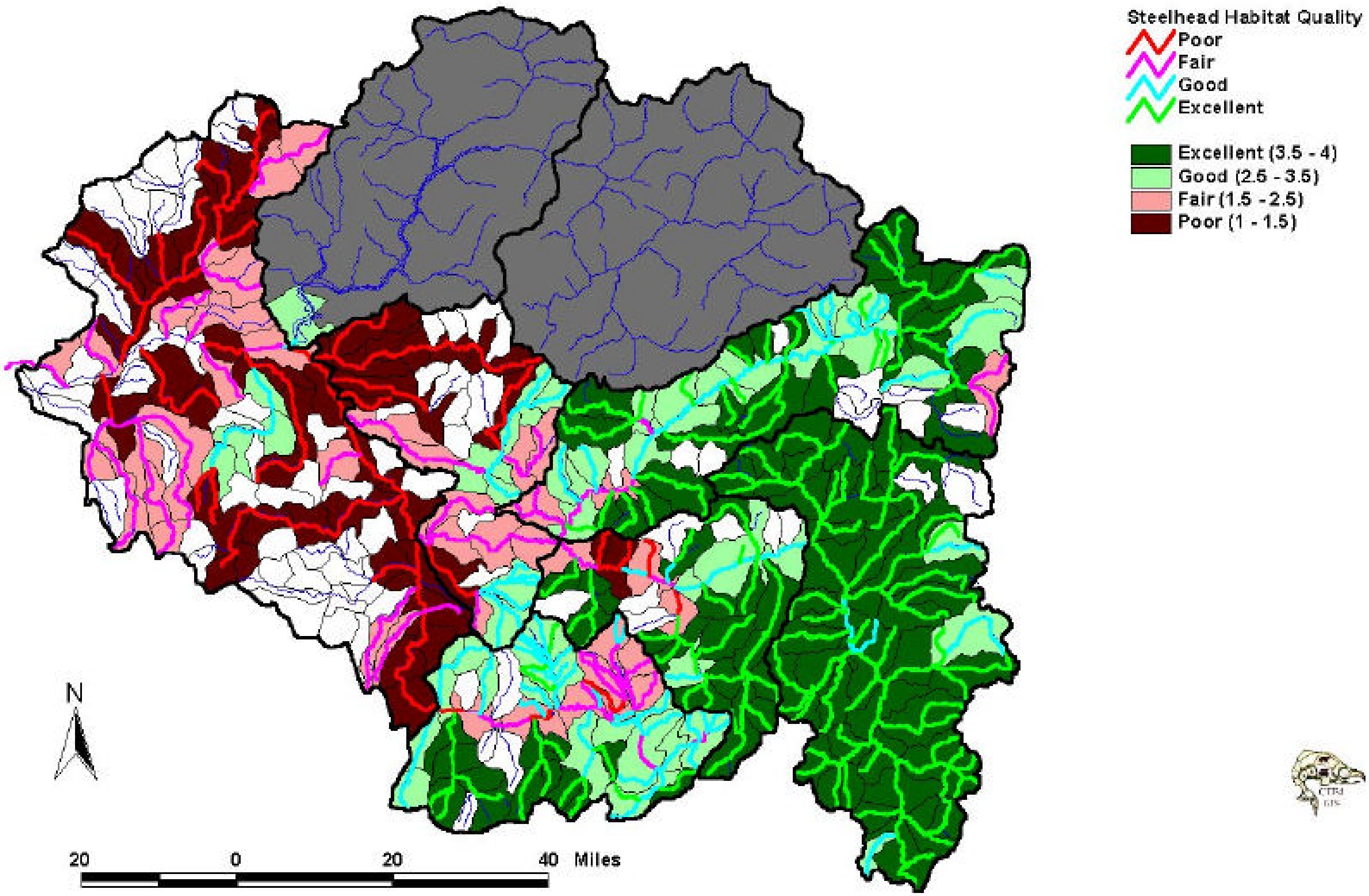

Figure 97. Habitat quality for steelhead trout as defined by NPPC's presence absence database (stream reaches) summarized by subwatershed

Specific habitat areas of critical importance to westslope cutthroat trout have not been defined within the Clearwater subbasin. Based on the current distribution and status of westslope cutthroat trout (Figure 105), it is presumed that the majority of the subbasin provides adequate habitat for maintenance of relatively strong population(s) of westslope cutthroat trout.

The construction of Dworshak Dam and Reservoir eliminated about 717,000 square yards of spawning habitat within the pool area that was suitable for resident trout and anadromous fish (USFWS 1962). This habitat loss is likely to have affected both bull trout and westslope cutthroat trout populations.

7.2 Aquatic Productivity

At the subbasin scale, understanding spatial patterns in potential production can be critical to restoration planning and evaluation efforts. Such an understanding can facilitate prioritization of restoration efforts and also provide a benchmark against which success of restoration efforts can be gauged.

Productivity is defined as the rate of production and illustrates how much of something (e.g. benthic biomass or numbers of smolts) can be produced over a given amount of time. Production is defined as the total output, illustrating how much is actually produced. In fisheries, spatial variations in production and productivity are commonly indexed (using differences in fish counts) rather than directly measured, leading to estimates of *relative* production or productivity between areas.

Fish production is driven by a variety of factors including local productivity, habitat quantity, and habitat quality. It is possible for an area of high productivity to realize relatively low production if habitat quantity or quality are limited. In contrast, an area of low productivity may realize relatively high production if high quality habitat is plentiful. Productivity is therefore an integral component of production although the reverse is not necessarily true. Increases in production can however, result in increased productivity in some areas, particularly in areas where anadromous fish spawn, die and decay, resulting in increased nutrient levels, which in turn, increase local productivity.

In the case of fish populations, production is often assessed through long term juvenile density data or spawner counts. Although a high degree of variability exists in natural populations, it can be assumed that over long periods, areas that produce more fish on average are more productive. Juvenile densities are influenced by a variety of factors including the number of spawners available to produce juveniles, and local habitat quality and quantity. Spawner counts are influenced by past production of juveniles, relatively long term (full life-cycle) survival rates, and in the case of anadromous species, temporal variation in migration and ocean conditions.

Datasets considered for use in examining potential fish production throughout the Clearwater subbasin are limited in both scope and utility. Relatively long term and consistently recorded data is available through redd surveys (adults) and the IDFG Parr Monitoring Database (juveniles). Both databases suffer from the following drawbacks which make them unsuitable for use in estimating relative production potential throughout the subbasin

- Both databases monitor and provide information only for those areas accessible to anadromous species.
- The majority of the data is from a post-dam time period. It can be reasonably argued that adult returns have been heavily influenced by out-of-subbasin issues (migration and ocean conditions) and that smolt production is reflective of adult recruitment (not local production potential).

Based on these drawbacks, both redd survey data and the Parr Monitoring Database were thought to be inappropriate for use in defining relative production potential throughout the Clearwater subbasin. Since information regarding spatial differences in production potential throughout the subbasin are thought to be critical to successful recovery planning, an experimental approach was developed to examine the use of benthic macroinvertebrate biomass as an indicator of relative production potential. Advantages of using macroinvertebrate biomass include

- Data collection can be completed in a relatively timely manner across broad geographic areas
- Measured as biomass, benthic macroinvertebrate production is highly dependent on local productivity (In contrast, commonly monitored macroinvertebrate community metrics such as diversity, richness, etc. are primarily driven by habitat condition)
- Spatial variation in benthic biomass production may be assumed to be potentially indicative of patterns in fish production at qualitative scales (H/M/L); areas producing high benthic biomass may be assumed to have the inherent capacity to produce more fish than areas producing less benthic biomass.

A study was conducted as part of this subbasin assessment process to evaluate the utility of using benthic biomass to assess spatial variation in potential production throughout the Clearwater subbasin. Fifth code HUCs were chosen to be consistent with similar work conducted by other agencies and are thought to be an appropriate scale at which to assess spatial variability in productivity for anadromous fish-bearing waters (Feist et al. Unpublished data).

The hypotheses tested by this study include the following:
1) differences in benthic biomass between 5th code HUCs can be identified using a relatively small number of samples within each HUC
2) at the 5th code HUC scale, qualitative differences in benthic biomass can be accurately described using landscape level features thought to influence production potential

Assumptions drawn for the purposes of conducting this study include
1) benthic macroinvertebrate production provides a useful index of local production potential
2) spatial variation in production potential will be directly reflected in benthic biomass, highly productive areas will consistently produce more benthic biomass than areas with lower production potential
3) while spatial variation in habitat quality would be expected to result in substantial differences in community composition, it does not significantly alter relative differences in benthic biomass between sampling locations

A total of thirteen 5th code HUCs in the Lochsa (6) and South Fork AUs were sampled for benthic biomass during July and August, 2000 (Table 40). Eight locations were sampled within each HUC (exceptions are 5 sites in John's Creek and 7 in Warm Springs Creek). Sampling locations were subjectively chosen and intended to provide a representative cross section of available habitat types within each HUC. Three benthic samples collected from each sampling site using a Surber sampler (0.093m^2) were combined into one composite sample (0.28 m^2) for biomass analysis. Biomass was determined by subtracting the ash free dry weight (AFDW) of the sample from the dry weight of the sample (refer to EPA 1973). Dry weight was obtained by drying samples at 105°C for 24 hrs. and then subtracting the weight of the crucible. AFDW was obtained by placing dried samples in a muffle furnace at 500°C for one hour, cooling, and then returning sample to a constant weight at 105°C and finally subtracting the weight of the crucible. The difference between dry and burned weight was used to define organic weight (biomass) for each composite sample.

Table 40. Relative production potential of each 5th code HUC in which benthic macroinvertebrate biomass data was collected

HUC Name [1]	5th Code HUC #	Assessment Unit	Mean Biomass (mg/0.28m^2)	Production Potential
American River	1706030506	South Fork	183.01	High
Meadow Creek	1706030502	South Fork	149.60	High
Red River	1706030507	South Fork	130.38	High
Crooked River	1706030508	South Fork	82.10	Moderate
Johns Creek	1706030510	South Fork	72.38	Moderate
Brushy Fk.	1706030307	Lochsa	70.46	Moderate
Newsome Creek	1706030505	South Fork	67.67	Moderate
Tenmile Creek	1706030509	South Fork	63.90	Moderate
Fish-Hungery Ck.	1706030302	Lochsa	51.73	Low
Bear (Papoose) Ck.	1706030304	Lochsa	45.34	Low
Walton Ck.	1706030308	Lochsa	42.06	Low
Warm Spring Ck.	1706030311	Lochsa	37.27	Low
Pete King Creek	1706030301	Lochsa	36.99	Low

1 Names assigned for identification purposes; indicates one (not all) named stream within each HUC.

Average biomass estimates for each 5th code HUC ranged from approximately 37 mg/site to 183 mg/site (Table 40). Analysis of variance indicated that significant differences in mean biomass existed between sampled HUCs ($p < 0.0001$). Hierarchical cluster analysis was subsequently used to define relative production classes for each sampled HUC, resulting in definition of three production classes: High (biomass >100mg), Moderate (biomass 60-85 mg), and Low (biomass <55mg; Figure 98). Identified breaks between classes correspond closely with those identified in a separate study by Burkantis (1998; High > 200 mg, Medium high 100-199mg, medium 50-99mg, and low < 50mg).

HUCs within the South Fork AU typically had higher benthic biomass than those in the Lochsa AU. All seven HUCs sampled within the South Fork AU were classified as having either "High" or "Moderate" productivity whereas 5 of 6 HUCs sampled within the Lochsa AU were classified as having "Low" productivity (Table 40).

Stepwise discriminant analysis was applied to develop a discriminant function which could be used to assign 5th code HUCs to the most likely relative production class. The discriminant function is essentially a predictive equation used to assign items (HUCs) to qualitative classes (H/M/L production potential) using quantitative data. Twenty-nine variables were assessed for their utility in discriminating relative production class. Variables assessed were generally landscape scale characteristics and included topography (4), elevation (5), geology (3), ownership (3), channel characteristics (4), watershed area (1), fish carrying capacity (2), canopy cover (4), and land disturbance (3). With the exception of fish carrying capacity (available only for anadromous production areas), variables were chosen based on consistent availability across the entire subbasin.

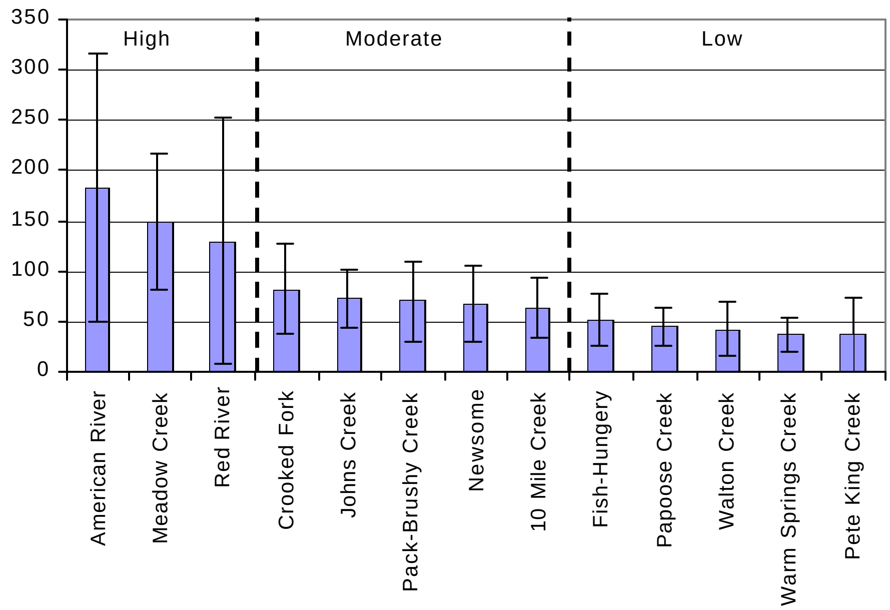

Figure 98. Mean biomass (mg/0.28m^2) $\pm$ one standard deviation sampled from each 5th code HUC. Sample size is 8 for all HUCs except Johns Creek (5) and Warm Springs Creek (7)

Results of the stepwise discriminant analysis indicated that benthic production of each 5th code HUC could best be predicted using two variables related to local topography (mean and standard deviation of land slope). The percent of channel length with gradient >20% was also selected during the stepwise process, but was removed from the model for statistical concerns (sample size vs. model complexity) and because it is largely a derivative of the other two variables.

Due to the small sample size, the ability of the discriminant function developed to accurately predict relative production classes was evaluated using cross-validation techniques. In summary, the method removes one sample from the set and calculates a discriminant function based on the remaining 12 samples. Factors used in this process are limited to those previously defined using the entire dataset (mean and standard deviation of land slope). The hold-out sample is then classified using the discriminant function developed from the other twelve samples. This process is repeated until each individual sample has been used as a hold-out and classified as having High, Moderate, or Low production potential.

Cross-validation suggests that the discriminant function developed during this process results in a relatively low degree of misclassification (Table 41). The overall error rate (misclassification) was 15.4%, and error rates for individual classification levels did not exceed 20%. All areas defined as having High production potential were properly classified using this technique. When misclassification did occur, the result tended to be overestimation of production potential (Low misclassified as Moderate, or Moderate misclassified as High).

Table 41. Classification matrix for potential production classes based on cross-validation techniques

		Into Potential Production Class				Error Rate
		High	Moderate	Low	Total	(%)
From Potential Production Class	High	3	0	0	3	0
	Moderate	1	4	0	5	20
	Low	0	1	4	5	20
	Total	4	5	4	13	15.4

Having determined that production potential of sampled HUCs could be predicted with a relatively high degree of accuracy, the discriminant function was then used to estimate the relative production potential of all 5th code HUCs within the Clearwater subbasin (Figure 99). It is crucial to note that landscape characteristics in the sampled HUCs did not constitute a representative sample of the range of conditions that exist throughout the Clearwater subbasin (Table 42). The level of confidence with which the developed discriminant function can be used to estimate production potential in dissimilar areas is unclear (e.g. developed in areas dominated by granitic and meta-sedimentary geology, the predictive function may or may not be applicable to areas dominated by volcanic geology).

Figure 99 also reflects the relative degree of confidence associated with the predicted production potential of each 5th code HUC. The degree of confidence was assigned subjectively based on how well landscape level characteristics in each HUC were represented by those from which actual sampling was conducted. A high degree of confidence was assigned if landscape attributes in the predicted HUC were reflective of those in sampled HUCs. A moderate degree of confidence typically signifies that one major landscape scale characteristic (listed in Table 42) differs from that of the sampled HUCs. A low degree of confidence was assigned to areas where multiple characteristics differ substantially from that of the sampled HUCs.

The confidence with which the model predicts production potential throughout the Clearwater subbasin is generally lowest in the Lower Clearwater and Lolo/Middle Fork AUs where landscape features differ dramatically from those in sampled areas. Modeling confidence is generally moderate to high throughout the Upper and Lower North Fork, Lochsa, Upper and Lower Selway, and South Fork AUs where landscape characteristics are most similar to sampled areas.

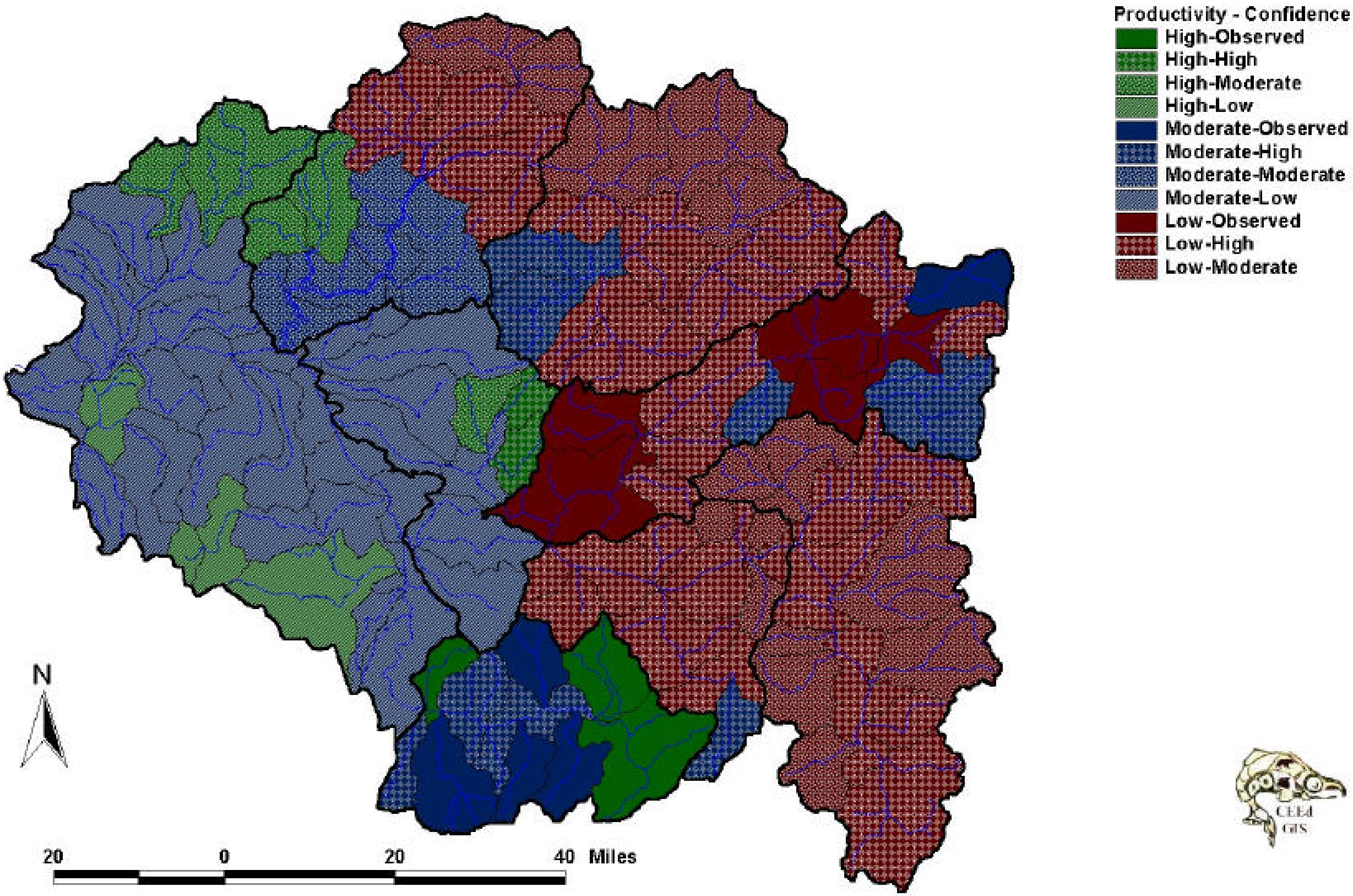

Figure 99. Predicted production potential and related degree of confidence for each 5th code HUC within the Clearwater subbasin

Table 42. Landscape scale characteristics of the Clearwater subbasin which may be useful to predict production potential. Characteristics representative of HUCs sampled during 2000 are presented in bold print.

Dominant Canopy Cover Class	Dominant Geology	Topography (Landforms)	Elevation Classes (m)	Dominant Ownership	Dominant Channel Gradient
< 15%	Quaternary	Foothills	500-750	Federal	Depositional (<4%)
15-39% [1]	Granitic	Plateau	750-1,000	State	**Transport (4-20%)**
40-69%	Volcanic	Breaks	**1,000-1,250**	Private Timber Co.	Source (>20%) [1]
>69%	**Meta-sedimentary**	Mountains	**1,250-1,500**	Other Private	
	Sedimentary [1]	Glaciated Mountains	**1,500-1,750**	Tribal [1]	
		Intermontane Basin	**1,750-2,000**		

1 Characteristic is not the dominant category in any 5th code HUC.

It is notable that results of this experimental model are consistent with the limited anecdotal information available about historic productivity of fish throughout the subbasin. The upper half of the South Fork Clearwater maintained a historically strong population of steelhead (Nez Perce National Forest 1998; Paradis et al. 1999b); the most substantial production of spring chinook salmon in the Lower Clearwater AU probably occurred in the Lolo and Potlatch Creek drainages (Clearwater National Forest 1997). Each of these drainages includes areas predicted to have high productivity during our modeling effort. Streams underlain by granitic geology (see Figure 6) are not typically expected to be highly productive for fish; these areas were most commonly predicted to have low productivity based on the experimental model results.

The overall theme represented by the factors selected during stepwise discriminant analysis can be summarized as topography. Experimental relaxation of the constraints used to develop the discriminant function suggested that two themes will dominate if sampling is expanded, topography and geology. However, due to the small sample size and limited distribution of samples used in this process, the actual utility of geology in predicting aquatic production potential at the landscape scale within the Clearwater subbasin remains unclear.

As subbasin planning proceeds, the need for additional, more comprehensive information regarding spatial variations in production potential should be considered. The primary intent of this analysis was to investigate the potential for using benthic macroinvertebrate biomass to differentiate spatial variations in production potential throughout the Clearwater subbasin. A small sample size (thirteen 5th code HUCs) certainly impacted the results of this analysis although results do suggest that both original hypotheses can be addressed using this approach. If additional information is required for subbasin planning process to proceed, an expanded systematic sampling approach should be developed to better represent the range of landscape conditions found throughout the subbasin. An expanded approach should lead to increased confidence associated with predictions of production potential, thereby enhancing the subbasin planning process.