1.2.10.3 Key Environmental Correlates

Key environmental correlates (KECs) (also termed Habitat Elements) are specific substrates, habitat elements, and attributes of species' environments that are not represented by overall (macro) habitats and vegetation structural conditions. Key environmental correlates are the finest scale features that help to define wildlife habitat. KECs recognize and attempt to qualify the high degree of influence either positive or negative the environmental correlates exert of the realized fitness of a species (Johnson and O'Neil 2001). They include natural elements (both environmental and physical), as well as anthropogenic features and their effects, such as roads, buildings, and pollution. Including these fine-scale attributes of an animal's environment when describing its habitat associations expands the concept and definition of a habitat, a term widely used only to characterize the vegetative community or structural condition occupied by a species (Johnson and O'Neil 2001). Failing to address and inventory KECs within these communities and conditions may lead to errors of commission; that is, species may be presumed to occur when in actuality they do not (Johnson and O'Neil 2001). The KECs identified to effect wildlife species across the Columbia Basin by Johnson and O'Neil are described in Appendix J (2001).

All KECs identified to influence habitat use by a focal species are summarized in Appendix K. The technical team reviewed the KECs identified to influence the wildlife species of the subbasin. Based on their understanding of the factors most influencing wildlife populations in the subbasin they identified roads and noxious weeds as limiting factors. These limiting factors are discussed in greater detail in section 1.5.2. The technical team identified strategies for reducing the negative impacts of these KECs on the wildlife populations of the subbasin in the Imnaha Subbasin Management Plan.

1.3 Out-of-Subbasin factors

Both aquatic and terrestrial species in the subbasin are affected by habitat conditions and features that occur outside of the subbasin. The species most impacted by these out-of-subbasin factors are species with large home ranges and species that migrate out of the subbasin to complete one or more lifestages.

1.3.1 Aquatic

Appendix N provides a regional overview of out-of-subbasin factors impacting anadromous fish in various areas throughout the Columbia Basin, including areas above Lower Granite Dam (which includes the Imnaha subbasin). Information presented here will focus on impacts to Snake River stocks and, when possible, those populations or stocks specific to the Imnaha subbasin. As mentioned earlier, Appendix G includes broader scale information.

1.3.1.1 Limiting Factors Outside Subbasin

It is generally accepted that hydropower development on the lower Snake River and Columbia River is the primary cause of decline and continued suppression of Snake

River salmon and steelhead (CBFWA 1991; NPPC 1992; NMFS 1995, 1997; NRC 1995; IDFG 1998; Williams et al. 1998). However, less agreement exists about whether the hydropower system is the primary factor limiting recovery (Marmorek et al. 1998). Other out-of-basin factors contributing to anadromous decline in the Imnaha include habitat losses, predation, fishing pressures, and hatcheries, most of which are influenced to some degree by the Columbia River hydropower system.

1.3.1.2 Estuary

Habitat losses in estuarine environments have also resulted from hydropower system operations. Storage in the upper Columbia and Snake rivers has altered the hydrograph. This alteration has resulted in a reduction in average sediment supply to the estuary, an increase in the residence time of water in the estuary and corresponding decrease in salinity, an increase in detritus and nutrient residence, and a decrease in vertical mixing (Sherwood, as cited in NRC 1996). These changes have converted the estuary to a less energetic system with high organic sedimentation rates. The changes have caused an overall loss of estuarine habitat used for rearing and has contributed to the dramatic decline in salmon populations.

1.3.1.3 Nearshore

El Niño events, combined with other climatic and oceanic phenomenon, have caused a shift in ocean conditions over the past two decades; impacting Columbia Basin salmon returns (NMFS 2000a). Based on the cyclic nature of the oceanic and climatic regimes, conditions are likely going to become more favorable for fish in the next decade (NMFS 2000a).

1.3.1.4 Marine

Patterns of Pacific Decadal Oscillation and salmon production would indicate that poor ocean conditions existed for Columbia River salmon after the late 1970s (Hare et al. 1999). However, the natural fluctuations of ocean productivity affecting all Columbia River stocks, in combination with mortality as a result of the hydropower system, appear to have caused the severe declines in productivity and survival rates for the Snake River stocks. Recent improvements in ocean conditions, however, appear to have had beneficial effects to survival rates, and are attributed partially to the increasing trend in chinook returns (DeHart et al. 2003).

1.3.1.5 Mainstem Habitat

The diversity of mainstem Snake and Columbia river salmonid habitat has been greatly diminished by the hydropower system. High-head dams in the Snake River upstream of the Imnaha have isolated populations and eliminated spawning and rearing habitat. The once lotic nature of the Snake and Columbia rivers has been all but compromised, altering flooding and draining patterns and isolating other habitat types.

Predation of salmonid smolts by various species also represents a potential limiting factor to survival, particularly within reservoirs. Shively et al. (1996) found that pikeminnow predation would be minimized when water velocity was greater than 1 meter per second and water depth exceeded 10 meters, suggesting that predation by pikeminnow is not a significant threat to outmigrating salmon within the Snake Hells Canyon subbasin itself due to the riverine nature of the reach. Predation by pikeminnow is, however, substantial throughout all or portions of the downstream migration corridor. Northern pikeminnow, a native predator, has become well adapted to the habitat created by river impoundment and has been shown to have substantial predatory impacts on migrating salmonids (Beamesderfer and Rieman 1991, Petersen 1994, Collins et al. 1995).

Other key piscivorous fish species, which may pose a potential limiting factor to anadromous salmonids in the migratory corridor, include walleye, channel catfish, Pacific lamprey, yellow perch, largemouth bass, northern pike, and bull trout (NMFS 2000b; Nelle 1999). Although not necessarily associated with the Snake Hells Canyon reach, these species have been found to consume considerable numbers of outmigrating subyearling chinook and steelhead and are most closely associated with areas upstream and downstream of impoundments. Avian predator populations are also blamed for salmonid predation. These include the Caspian tern, double-crested cormorant, and three species of gulls (NMFS 2000b). Marine mammals, specifically members of the order pinnepedia, represent additional threats to chinook and steelhead (NMFS 200b).

1.3.1.6 Hydropower

Development and operation of the Federal Columbia River Power System, which for the Imnaha includes four dams on the lower Columbia River and four on the lower Snake River, inflicts the largest human-caused toll on Columbia Basin salmon, killing 20 to 40% of the adults and about 80% of young fish (NRC 1995). This limiting factor keeps yearly effective population size low and increases genetic and demographic risk of localized extinction.

History of the Federal Columbia River Power System

The presence of dams on the Columbia and Snake Rivers began with the congressional authorization for the construction of Grand Coulee and Bonneville dams in the early 1930s. This construction initiated the "taming of the Columbia," a period during which the eight dams currently impeding Imnaha salmon and steelhead were erected. The Bonneville Dam project began in 1933 as an emergency public works project designed to provide jobs and stimulate the Depression economy (Blumm and Bodi, as cited in Cone and Ridlington 1999). Although hydropower production was one of the benefits that Congress sought from the projects, the dams' primary purpose was navigation (in the case of Bonneville) and flood control, downstream flow regulation, and irrigation (in the case of Grand Coulee) (Blumm and Bodi, as cited in Cone and Ridlington 1999). As Bonneville Dam neared completion, the 1937 Bonneville Project Act was initiated, which provided a vehicle for marketing surplus power. The act produced the Bonneville Power Administration (BPA), which was authorized by Congress to market power from the projects and construct transmission lines to serve the rural Pacific Northwest (Blumm and Bodi, as cited in Cone and Ridlington 1999).

A 1937 report studying the potential effects of Columbia River dam construction on anadromous fish acknowledged the multitude of problems that salmon would inevitably face, including bypass problems for juvenile fish, unscreened irrigation diversions, unsophisticated hatchery technology, and mixed-stock ocean harvests (Blumm and Bodi, as cited in Cone and Ridlington 1999). The report prompted enactment of the Mitchell Act in 1938, which authorized spending for additional scientific studies and funding of measures to preserve and protect Columbia Basin salmon, including hatcheries, fish ladders, irrigation screens, and habitat protection and restoration projects.

A U.S. Army Corps of Engineers report describing development of the lower Snake River for hydropower and navigation was completed in 1938. The report shifted federal emphasis from the mid-Columbia to the lower Snake, and from power to navigation benefits. The report discussed the benefits of making Lewiston, a town over 400 miles inland from the Pacific Ocean, a deepwater port. Although Congress was slow to adopt the plan due to World War II, it eventually passed an omnibus Rivers and Harbors Act in 1945 and adopted U.S. Army Corps of Engineers recommendations for lower Snake River development, anticipating the benefits the construction would have on employment of returning soldiers and post-war economic stabilization (Blumm and Bodi, as cited in Cone and Ridlington 1999).

Authorization for the construction of McNary Dam was also granted in 1945, with the express statute that the project protect salmon migration, promising anadromous fish "free access to their spawning grounds" (Blumm and Bodi, as cited in Cone and Ridlington 1999). Dam operations did not, however, ascribe to the statute, and instead assumed that dam-related salmon losses could be offset through reliance on hatcheries (Blumm and Bodi, as cited in Cone and Ridlington 1999). Congressional authorization for the construction of The Dalles and John Day dams was given in 1948 following disastrous flooding in the spring of the same year. That same year Congress directed the U.S. Army Corps of Engineers to review its plan for the Columbia Basin, which yielded a report that relied heavily upon flood control as a rationale for the projects it recommended.

Construction was completed on John Day, Lower Monumental, and Little Goose in 1968, 1969, and 1970, respectively. Upon their completion, all Columbia and Snake River dams were equipped with fishways that permitted adult passage (NRC 1995). Downstream-migrant facilities were also constructed (or recently reconstructed) on all eight dams. The construction timing of the Columbia and Snake River dams impacting Imnaha salmon and steelhead are shown in Table 86.

The "taming" of the Columbia and Snake rivers ended in the 1970s, as potential sites and public support for new dam construction had been exhausted (NRC 1995). The effects of the dams on anadromous fish loss proved significant. Imnaha chinook production, based on annual redd counts, was severely reduced following the construction of The Dalles Dam in 1957 (D. Bryson, NPT, personal communication, 2001). Redd counts declined even further following construction of Lower Monumental and Lower Granite dams. A recent evaluation of 25 years of juvenile survival statistics found that an estimated 13 to

14% of emigrating smolts are lost annually at each lower Snake and Columbia river dam (Bickford and Skalski, as cited in Ashe 2000).

Table 86. Chronology of the eight U.S. Army Corps of Engineers dams that currently impede migration of Imnaha anadromous salmonids.

Dam	River	Year Constructed
Bonneville	Columbia	1938
McNary	Columbia	1953
The Dalles	Columbia	1957
Ice Harbor	Snake	1961
John Day	Columbia	1968
Lower Monumental	Snake	1969
Little Goose	Snake	1970
Lower Granite	Snake	1975

Effects of the Federal Columbia River Power System

The Columbia Basin hydropower system may kill or harm migrating fish by through any of the following actions:

- Creating deadly high water temperatures in the slackwater reservoirs
- Creating conditions that increase predation on young salmon by other fish and birds
- Reducing river flows needed to help young salmon reach the sea
- Forcing some young fish into deadly turbines
- Forcing many young fish into stressful collection systems and then into barges and trucks
- Blocking upstream migrations of adult fish
- Covering spawning habitat with silt and deep water

When encountering dams, salmon and steelhead may be delayed at ladders on their upstream migration or in the pools on their downriver migration. The delays may cause reduced fitness or mortality. After reaching the actual structure, juveniles pass or attempt to pass in one of four ways: by falling over the dam as a result of water purposefully spilled from the top; swimming through a looped fish bypass tube that brings the salmon down near the bottom of the dam first, then up near the surface to a collection channel, then down again and finally out the bottom on the other side of the dam; traveling in a barge; or navigating a turbine. All passage attempts generally come at a biological price (NRC 1995). When spilled over the top of the dam, juvenile fish may be killed or injured by the fall, by gas supersaturation, or by opportunistic predators awaiting the disoriented fish. Juvenile fish bypass and collection facilities also exact tolls on migrating salmonids. The juveniles may come into contact with various surfaces of the facility, causing impingement, bruising, descaling, and stress (Chapman, as cited in NRC 1995). Stress accompanies the bypass process, and when fish are delivered directly to the river, may cause disorientation and subsequent predation. Predators also key in on the comparatively high densities of fish located at bypass outfall areas (NRC 1995). Turbine mortality was higher prior to the retrofitting of many dams with bypass collection facilities but continues to represent a lethal toll.

When anadromous fish out-migrate from the hydropower system but fail to return to their natal habitat as adults, they are said to have experienced delayed mortality. The loss can be attributed to a number of factors, including ocean conditions, harvest, stock viability, habitat conditions, predation, and the hydropower system. A recent study contends that much of the delayed mortality experienced by Snake River anadromous salmonids is related to their hydropower system experience (Budy et al. 2001). The study established that direct mortality from hydropower eliminates 25 to 73% of juveniles and adults, after which Snake River fish may experience 37 to 68% “additional mortality” or delayed mortality (Budy et al. 2001). The study offers direct evidence relating direct mortality to hydropower based on PIT-tagged fish. The PIT data show that, while direct mortality is lower for salmon transported via barge than for fish that navigate the dams, delayed mortality is higher for fish transported via barge (Budy et al. 2001). The authors attribute this result to the stress experienced in the hydropower system and collection channels. The PIT data reflect even higher delayed mortality in fish that pass through one or more dams and are then collected and transported from a lower dam.

Currently, the estimated direct survival of Snake River spring/summer chinook smolts through the hydropower system is between 40 and 60%, compared with an estimated survival rate during the 1970s of 5 to 40%. These improvements have occurred as a result of changes in the operation and configuration of the FCRPS, which include increased spill, barging, increased flow, changes in the operation of turbines, and new extended-length screens at McNary, Little Goose, and Lower Granite dams (NMFS 2000a).

In 1996, the Comparative Survival Study (CSS) was initiated to estimate survival rates over different life stages for spring/summer chinook (DeHart et al. 2003). The overall goal of the CSS is to monitor and evaluate the impacts of mitigation measures and actions (e.g., flow augmentation, spill, and transportation) instituted under the NMFS biological opinion to recover listed stocks. Major objectives of the study include (1) development of a long-term index of transport smolt-to-adult returns (SAR) to in-river SAR for Snake River hatchery and wild spring/summer chinook smolts measured at Lower Granite Dam (LGR); (2) develop a long-term index of survival rates from release of smolts at Snake River hatcheries to return of adults to the hatcheries; (3) compute and compare the overall SARs for selected upriver and downriver spring/summer and summer chinook hatchery and wild stocks; and (4) begin a time series of SARs for use in hypothesis testing and in the regional long-term monitoring and evaluation program. The primary focus in DeHart et al. (2003) is for wild and hatchery spring/summer chinook that outmigrated in 1997 to 2000 and returned in 2003.

Findings from DeHart et al. (2003) include:

- The SARs of transported and in-river migrants are well below the 2-6% SARs needed to recover Snake River spring/summer chinook. Despite overall low SAR levels, SARs for chinook from the Imnaha hatchery have increased annually reaching levels over 2% in most study categories in 1999 and 2000. In most cases, Imnaha hatchery smolts that were transported had higher SARs than their in-river counterparts

- There were little or no transport benefits for wild Snake River chinook in most years (1994-2000)

- Delayed hydrosystem mortality was evident for transported Snake River hatchery chinook smolts, which died at a greater rate after release than hatchery smolts that migrated through the hydrosystem in 1997-2000

- Delayed hydrosystem mortality was evident for transported Snake River wild chinook smolts, which died at a greater rate after release than wild smolts that migrated through the hydrosystem in 1994-2000

Adult escapement of anadromous species remains low even given significant hatchery production/supplementation efforts. Low adult abundance has resulted in stocking at variable rates between years, depending on the availability of brood fish (Walters et al. 2001). Smolt-to-adult return rates (SAR), from smolts at the uppermost dam to adults returning to the Columbia River mouth, averaged 5.2% in the 1960s before hydropower system completion and only 1.2% from 1977 to 1994 (Petrosky et al. 2001) (Figure 66). This rate is below the 2 to 6% needed for recovery (Marmorek et al. 1998).

In contrast to the decline in SAR, numbers of smolts per spawner from Snake River tributaries did not decrease during this period, averaging 62 smolts per spawner before hydropower system completion and 100 smolts per spawner afterward (Petrosky et al. 2001) (Figure 66) In this summary, both spawner escapement and smolt yield are measured at the uppermost mainstem dam (currently Lower Granite). The increase in smolts per spawner was due to a reduction in density-dependent mortality as spawner abundance declined. Accounting for density dependence, a modest decrease occurred in smolts per spawner from Snake River tributaries over this period but not of a magnitude to explain the severe decline in life-cycle survival (Petrosky et al. 2001).

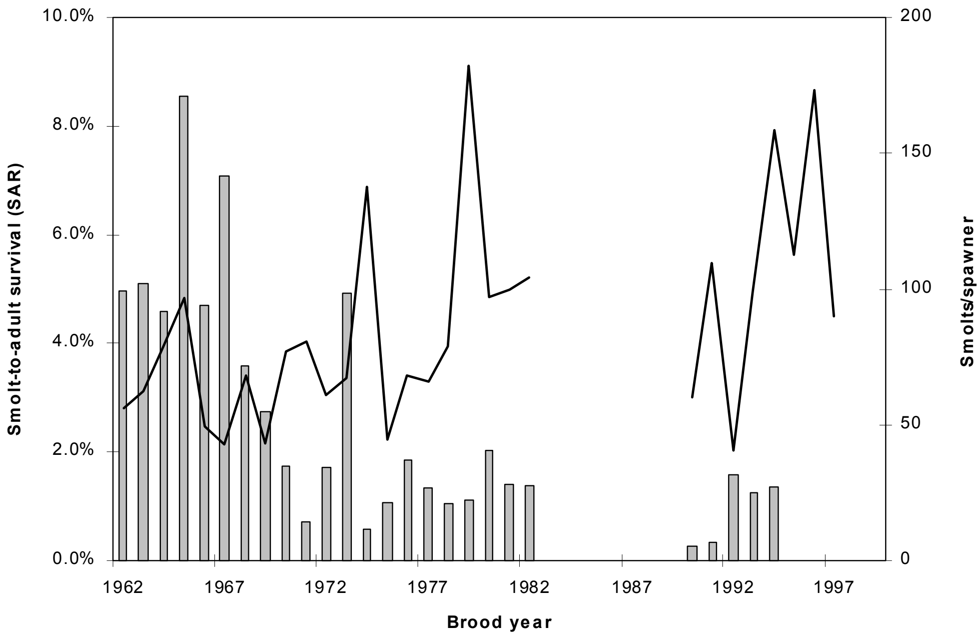

Figure 66. Smolt-to-adult survival rates (SAR; bars) and smolts/spawner (solid line) for wild Snake River spring/summer chinook. The SAR describes survival during mainstem downstream migration to adult returns, whereas the number of smolts per spawner describes freshwater productivity in upstream freshwater spawning and rearing areas (from Petrosky et al. 2001).

The SAR and smolt per spawner observations (Figure 66) indicate that the overall survival decline is consistent primarily with hydropower system impacts and poorer ocean (out-of-subbasin factors), rather than large-scale impacts within the subbasins between the 1960s and present (Schaller et al. 1999, Petrosky et al. 2001). Because the smolt/spawner data represent aggregate populations from a mix of habitat qualities throughout the Snake River basin and are from a period after development, they do not imply that there is no room for survival improvement within the Salmon, Clearwater, Grande Ronde, and Imnaha subbasins. However, because of limiting factors outside the subbasin and critically reduced life-cycle survival for populations even in pristine watersheds, it is unlikely that potential survival improvements within the Snake River subbasins alone can increase survival to a level that ensures recovery of anadromous fish populations.

1.3.1.7 Out-of-Subbasin Harvest

Mixed stock commercial fisheries (both tribal and nontribal) have taken a large toll on anadromous runs. Fishing pressures, combined with dam mortality, have substantially contributed to coho extinctions in the Snake River system and have significantly contributed to the imperiled status of chinook and sockeye in the Snake River system.

NMFS (2000a) estimates that approximately 9% of the spring/summer chinook run is subjected to total in-river (tribal, commercial, sport) harvest. Due to migration patterns of these stocks in conjunction with fishing seasons, ocean harvest is nearly nonexistent. The TAC (1997, as cited in Ashe 2000) concluded that the ocean fishing rate for upriver spring/summer chinook is probably less than 2%, one of the lowest rates of all Columbia River stocks. For Snake River fall chinook, a much more abundant stock, combined ocean and in-river harvest is less than 30% (NMFS 2000a).

Tribal harvesters, those guaranteed by treaty to fish, have reduced annual harvest to a fraction of historical levels but continue to fish commercially for various species. There were treaty and nontreaty commercial seasons for spring/summer chinook in 2001–2003.

1.3.1.8 Hatcheries

There has been considerable concern that hatchery-reared salmon and steelhead have reduced the prevalence of wild anadromous salmonids through competitive interaction, genetic introgression, and disease transmission (Ashe et al. 2000). The fact that more than 70% of Oregon's salmon start life in a fish hatchery (http://www.oregonvos.net/salmon) lends credence to this concern. Also, the mixed stock fishery that has been created through the introduction of hatchery fish has resulted in increased harvest rates of wild/natural fish.

The role of salmon hatcheries has shifted several times over the years between a remedy for lost fish habitat to a method of helping boost wild salmon stock. In 1938, Congress passed the Mitchell Act to provide federal money for aggressive construction of hatcheries as a way of replacing the thousands of acres of salmon spawning grounds blocked or flooded behind dams (Cone and Ridlington 1999). Subsequently, more than 80 hatcheries were built in the Columbia Basin.

Early hatchery management often involved little more than transporting the biggest, most desirable species of salmon from one river to another. Little was understood then about the unique genetic makeup of each salmon stock and their innate ability to return to their natal streams.

Between the mid-1950s and early 1970s, scientists became increasingly concerned with the effects hatchery fish were having on wild fish. They contended that the mass production of hatchery salmon was harming the remaining wild salmon runs and endangering the future welfare of salmon populations. Studies determined that hatchery fish had lower survival rates in the ocean than wild fish, and offspring from hatchery fish had lower genetic fitness than wild fish. And because hatchery salmon do not return to upriver spawning grounds, the nutrients released from decomposing carcasses is lost.

In the last ten years, some changes have occurred with respect to reform of hatchery management and artificial production; however, many hatcheries continue to operate under a "numbers game" driven by large production goals for hatchery programs to provide fish for harvest and sale (B. Smith, ODFW, personal communication, April 2003). Hatchery Genetic Management Plans, or HGMPs have been conducted by

NMFS for the Columbia Basin (including the Imnaha) in an attempt to improve return rates and reduce competitive interactions with natural populations (NMFS 1999; Ashe et al. 2000). The plans outline restoration strategies using appropriate stocks, release strategies, rearing densities and release locations. ODFW believes further assessment and adaptation of hatchery production numbers relative to natural population needs would be beneficial (B. Smith, ODFW, personal communication, April 2003).

1.3.2 Terrestrial

Many of the wildlife species of the Imnaha subbasin spend a portion of their life cycle outside the Imnaha subbasin boundaries. This can complicate and potentially reduce the effectiveness of wildlife management actions in the subbasin. Depending on the extent, location, and timing of seasonal movements, out of subbasin effects may range from limited to substantial.

Migratory birds are the species that travel the greatest distance outside of the subbasin. Three of the focal species in the subbasin are neotropical migrants that breed in the subbasin and winter in Mexico or Central America. Flammulated owls are the most migratory of all North American owls, going south of Mexico during most of the fall and winters. Grasshopper sparrows winter in the southern United States, south into Central America (Vickery 1996). The olive-sided flycatcher is migratory and winters in Central and South America (Csuti et al. 1997). Environmental toxins, and habitat degradation in these species winter habitats could have negative impacts on populations of the species in the Imnaha subbasin. Marshall (1988) speculated that the disappearance of the olive-sided flycatcher from suitable, unchanged habitat in California was caused by the destruction of habitat in Central America, where this population maintained their winter territories. Birds migrating to Mexico and Central and South America, where environmental regulations are not as strong as in the U.S., continue to be exposed to relatively high levels of organochlorines. This group of chemicals includes DDT, the pesticide that caused egg shell thinning, reproductive failure and dramatic declines in bald eagle populations in the 1940s. DDT was banned in this country in 1972 but is still used in many other parts of the world (DeWeese et al. 1986).

Many other species in the subbasin make movements of smaller distance out of the subbasin. Large game species including the bighorn sheep, mountain goat, elk, and mule deer focal species may migrate into and out of the subbasin. This commonly results in crossing wildlife management units and potentially state boundaries and can complicate the setting of appropriate hunting seasons and harvest limits. Game species may experience greater hunting pressure when they move out of the subbasin into the more populated surrounding areas. Other potential out of subbasin impacts to game species include increased contact between bighorn sheep and domestic sheep and increased potential for disease transmission.

Species may migrate out of the subbasin in search of habitat and forage, finding high quality habitat may allow for increased populations in the subbasin, while use of unsuitable habitats may result in reduced populations. The neighboring Snake Hells Canyon subbasin has been recognized as having some of the most crucial big game winter habitat in the region. It is thought that these winter range areas may help support deer and elk populations throughout the region including those in the Imnaha subbasin (Christensen 2001). Use of habitat outside the subbasin may also have negative impacts on the game species in the subbasin. Agricultural areas are very limited in the subbasin but elk and particularly mule deer may migrate outside of the subbasin and forage on private agricultural lands. This results in reduced social carrying capacity and results in public pressure to reduce population management objectives. The relatively high quality grassland habitats of the subbasin provide suitable breeding habitats for grasshopper sparrow. But grasshopper sparrows are also documented to use agricultural areas and hayfields, these areas are not as suitable for breeding grasshopper sparrows and may serve as population sinks (Wisdom et al 2000).

Species with very large home ranges that occur in low densities may migrate into and out of the subbasin in search of prey and mates. Fisher, marten, and particularly lynx and wolverine are species with large home range sizes that may inhabit the Imnaha subbasin. Maintaining and enhancing the integrity of movement corridors for these species may prove critical to maintaining genetic diversity and healthy populations of these species. For instance, mapping of documented wolverine sightings conducted by Edelmann and Copeland (1999) suggests that a narrow corridor in the Seven Devils mountain area of the Snake Hells Canyon Subbasin may provide the only suitable habitat linking wolverine subpopulations in Idaho and Oregon. Reductions of dispersal rates through the corridor may impact the regional viability of wolverine by reducing genetic interchange and lowering the likelihood that all suitable habitat patches are continuously inhabited (Edelmann and Copeland 1999).

1.4 Environment–Population Relationships

Up until this point, this document have focused largely on how changes to terrestrial and aquatic habitats in the subbasin have likely influenced fish and wildlife populations. However, environmental conditions, including habitat and resources available for other species, are influenced by the ecological roles of organisms. Fish and wildlife species perform ecological roles within their environment, and these roles can influence and alter the biotic and abiotic environments they inhabit. These interactions are termed key ecological functions (KEFs).

1.4.1 Aquatic

The literature review regarding the relationships between salmonid populations and their environment is lengthy. Discussions specific to Imnaha focal species and aquatic habitat are provided in section 1.2.5. Discussions about limiting factors specific to life stages of focal species found in the Imnaha subbasin are provided in section 1.5.

Discussions of relationships between spring/summer chinook and their environment may be found in Thompson (1960), the Nez Perce Tribe (1990), Jonasson (1994), Ashe (1995), Carmichael (1995), Mobrand (1995), Sankovich (1995), Myers (1998), Ashe (2000), Cleary (2000), Wallowa-Whitman National Forest (2003), and Cleary et al. (2003).

In-depth discussions of relationships between steelhead and their environment may be found in Thompson (1960), Gaumer (1968), the Nez Perce Tribe (1990), Jonasson (1994), Ashe (1995), Busby (1996), Mundy (1998), USFS (1998), Cleary (2000), Wallowa-Whitman National Forest (2003), and Cleary et al. (2003).

Discussions regarding relationships between fall chinook and their environment are provided in Thompson (1960), the Nez Perce Tribe (1990), Mason (1993), Myers (1998), Garcia (1999, 2000), Connor (2002), and Wallowa-Whitman National Forest (2003).

Discussions focusing on relationships between bull trout and their environment are available in Hemmingsen (1996), Wallowa-Whitman National Forest (1996, 2003), Buchanan (1997), USFS (2001), and USFWS (2002b).

There are limited amounts of information regarding species–environment relationships for lamprey; however, some background discussion may be found in Gaumer (1968), Close (1995) and Kostow (2003).

1.4.2 Terrestrial

Eighty-seven different KEFs preformed by terrestrial species have been identified (Johnson and O'Neil 2001). The 87 KEFs fall within the eight broad classes of functions listed below, more detailed definitions of the 87 KEFs are contained in Appendix M.

1) Trophic relationships
2) Aids in physical transfer of substances for nutrient cycling
3) Organismal relationships
4) Carrier, transmitter, or reservoir of vertebrate diseases
5) Soil relationships
6) Wood structure relationships
7) Water relationships
8) Vegetation structure and composition relationships

KEFs are hierarchical in nature and so a species that performs the KEF of consuming terrestrial vertebrates also provides the invertebrate eater, secondary consumer, and heterotrophic consumer KEFs. To help illustrate this concept the trophic relationship ecological functions preformed by the American avocet are displayed in Table 87.

Table 87	Trophic relationship KEF preformed by the American avocet (*Recurvirostra americana*)

KEF Code	KEF Description
1	Trophic relationships
1.1	heterotrophic consumer
1.1.2	secondary consumer (primary predator or primary carnivore)
1.1.2.1	invertebrate eater
1.1.2.1.1	terrestrial invertebrates

KEF Code	KEF Description
1.1.2.1.2	aquatic macroinvertebrates
1.1.2.2	vertebrate eater (consumer or predator of herbivorous vertebrates)
1.2	prey relationships
1.2.1	prey for secondary or tertiary consumer (primary or secondary predator)

Most KEFs are preformed by a variety of different species in the subbasin. KEFs preformed by a greater number of species are described as having a higher level of functional redundancy. If one species that performs a KEF with a high level of functional redundancy is extirpated from the ecosystem, the impacts are less severe than if a species that is one of a few or the only species that performs that KEF is extirpated (Johnson and O'Neil 2001). Critical functional link species are the only species that perform a specific ecological function in a community. Their removal would signal loss of that function in the community. Thus, these species are critical to maintaining the full functionality of a system (IBIS 2003). Thirty-two species have been identified as critical functional link species in the Blue Mountain Ecoprovince. Examples of the critical functions contributed by critical functional link species in the subbasin include the physical fragmentation of standing wood by the black bear in herbaceous wetland and alpine grassland habitats, the impoundment of water behind diversions or dams by the American beaver in numerous habitat types, and the creation of roosting, denning, or nesting opportunities by the red squirrel in various forest habitats (see Appendix M a complete list of critical functional link species and their critical functions).

1.4.3 Key Relationships between fish and wildlife

As described in section 1.4.1 aquatic species and particularly salmonids provide a variety of KEFs in the subbasin and across the Columbia Basin and form an important link between marine, freshwater aquatic and terrestrial environments. Anadromous salmon help to maintain ecosystem productivity and may be regarded as a keystone species. Salmon runs input organic matter and nutrients to the trophic system through multiple levels and pathways including direct consumption, excretion, decomposition, and primary production. Direct consumption occurs in the form of predation, parasitism, or scavenging of the live spawner, carcass, egg, or fry life stages. Carcass decomposition and the particulate and dissolved organic matter released by spawning fish deliver nutrients to primary producers (Cederholm et al. 2000). Relationships between wildlife species and salmon vary in terms of their strength; the categories that have been developed to characterize these relationships and are briefly described below see (Cederholm et al. 2000 and Johnson and O'Neil 2001 for more details):

- Strong-consistent relationship-Salmon play or historically played an important role in this species distribution viability, abundance and or population/status. The ecology of this wildlife species is supported by salmon, especially at particular lifestages or during specific seasons.
- Recurrent relationship- The relationship between salmon and this species is characterized as routine, albeit occasional, and often in localized areas (thus affecting only a small portion of this species population).

- Indirect relationship- Salmon play an important routine, but indirect link to this species. The relationship could be viewed as one of a secondary consumer of salmon; for example salmon support other wildlife that are prey of this species.
- Rare relationship- Salmon play a very minor role in the diet of these species often amounting to less than 1 percent of the diet.

Salmon fishes (including their eggs) are a major source of high-energy food that allows for successful reproduction and enhanced survival of many wildlife species. Sixty-seven birds, twenty-three mammals, three reptiles and one amphibian species thought to inhabit the Blue Mountain Province consume salmon during one or more of salmon's lifestages (IBIS 2003). Twenty-five of the ninety-four total species in the province with a relationship to salmon are concern or focal species, these species and their relationship to salmon are displayed in Table 88. The reductions in the salmon runs of the subbasin described in sections 1.2.3-1.2.5, have reduced nutrient inputs into the ecosystem and probably the suitability of the subbasin for many of the wildlife species that consume salmon. For this reason, reductions in anadromous fish populations and the KEFs they provide, were identified as a limiting factor to wildlife (see section 1.5.2 for details ad the Imnaha Subbasin Management Plan for strategies aimed at reducing the impact of this limiting factor on the subbasins wildlife populations.

Table 88. Concern or focal species of the Imnaha subbasin that consume salmon during one or more salmonid lifestages (IBIS 2003).

Common Name	Scientific Name	Relationship
American marten	*Martes americana*	Rare
Bald eagle	*Haliaeetus leucocephalus*	Strong-consistent, indirect
Bank swallow	*Riparia riparia*	Indirect
Barrow's goldeneye	*Bucephala islandica*	Recurrent, Rare
Gray wolf	*Canis lupus*	Recurrent
Harlequin duck	*Histrionicus histrionicus*	Strong-consistent, indirect
Horned grebe	*Podiceps auritus*	Rare
Peregrine falcon	*Falco peregrinus*	Indirect
Red-necked grebe	*Podiceps grisegena*	Rare
Willow flycatcher	*Empidonax traillii*	Indirect
Wolverine	*Gulo gulo*	Rare

1.5 Identification and Analysis of Limiting Factors and Conditions

Descriptions of how natural resources in the Imnaha subbasin have changed from historical to current are provided throughout various portions of the assessment. A chronology of the influence of human occupation and land use activities (historical through current) on terrestrial and aquatic resources is provided at the subbasin level in section 1.1.1.10, including the effects of population growth (p. 36), grazing (p. 38), transportation (p. 42), timber harvest (p. 46), agriculture (p. 51), water development (p. 52), and mining (p. 57). Discussions of how water quality (temperature) has been altered in various subwatersheds are provided in section 1.1.2.3 (p. 65). We examine the influence of natural and anthropogenic disturbance on ecologic processes in section 1.1.3 (p. 79) by focusing on climate, hydrology, erosion, fire, and pathogens. Out-of-subbasin conditions and limiting factors are provided in section 1.3 (p. 259).

Although the previous discussions/characterizations provide insight relative to changes in aquatic and terrestrial resources, they are relatively global in their treatment of the issues. The following sections are therefore devoted to the specific definition of key limiting factors to focal fish and wildlife populations.

1.5.1 Local Factors Limiting Aquatic Focal Species

As discussed previously, declines in relative abundance of the five aquatic focal species (see section 1.2) are associated with changes (i.e., from historical to current) in habitat quantity and quality, both within and outside of the subbasin. Natural and anthropogenic disturbance pressures have caused changes to habitat-forming ecological processes (see section 1.1.3), which have directly and/or indirectly acted to modify habitat conditions.

Within the Imnaha subbasin, high summer water temperatures, insufficient water quantity, areas of inadequate riparian vegetation, low pool quality and frequency, inadequate amounts of LWD, habitat alteration, and excessive sedimentation due to roads are commonly cited as the primary in-basin factors limiting Imnaha fish production, distribution, and population stability (Mason et al. 1993, Huntington 1994, USFS 1994a, Mobrand and Lestelle 1997, Ashe et al. 2000, USFS 2003d). However, factors limiting local fish production or survival may differ from those defined across broader scales, and will vary by species and location.

1.5.1.1 Local Limiting Factors–Spring/summer Chinook

Primary factors limiting spring/summer chinook production in the Imnaha include high stream temperatures, low flows during late season migration, excessive fine sediment, poor riparian condition, low habitat diversity, and low/limited adult escapement or low population size. Areas where these problems are most significant include the lower and upper reaches of the mainstem Big Sheep Creek (RM 0–RM 17, RM 25–RM 34) and the lower half of the mainstem Imnaha River (RM 16). Low/limited adult escapement or low population size is a subbasin-wide limiting factor. A textual discussion of limiting factors specific to life stage is provided below.

Migration—Adult and Juvenile

Wallowa County and Nez Perce Tribe (1993) and Huntington (1994) identified high stream temperatures in the lower Imnaha to be a potential concern for the success and timing of upstream migrating adult chinook salmon. Mobrand and Lestelle (1997) also noted temperature increases from historical levels in the lower river corridor (below Freezeout Creek, RM 29.4) yet did not specifically identify the change as a factor limiting productivity. The patient-template analysis of the mainstem suggests that the relative productivity (survival) of Imnaha chinook salmon has been reduced due to losses in key life history stages, including pre-spawning adults (Mobrand and Lestelle 1997).

Pre-spawning life history stages have been compromised in the middle to lower reaches of the river by losses in habitat diversity and streambed instability (Mobrand and Lestelle 1997). Upon review of the available information, Ashe (et al. 2000) proposes that while high stream temperatures may stress the fish, migration will not be prohibited and rates early season migration as excellent and late season migration conditions to be fair to good.

Wallowa County and the Nez Perce Tribe (1993), Huntington (1994), and Mobrand and Lestelle (1997) identify summer temperatures, flows and sediment loads as potential problems for spring/summer chinook migration into Big Sheep Creek. Upon review of the available information, Ashe (et al. 2000) rates early season migration conditions as "excellent" and late season migration conditions as "fair to poor" (based on temperatures and possible flow concerns).

The emigration of chinook smolts from the Imnaha subbasin does not appear to be limiting the productivity of the population as a whole (Ashe et al. 2000). This is especially true during the early part of the migration between March and April. Smolts that outmigrate later than April are more likely to encounter elevated temperatures, such as in the lower Imnaha and in lower Big Sheep Creek, which may delay or postpone emigration (Gaumer 1968). Ashe (et al. 2000) summarizes smolt outmigration conditions to be excellent in the early part of the migration and good in the latter part of the migration for both the mainstem and Big Sheep Creek.

Spawning and Incubation

In their patient-template analysis, Mobrand and Lestelle (1997) found that the quantity of key chinook habitat has declined in certain portions of the subbasin, and specifically that insufficient substrate size in the middle portions and upper reaches of the Imnaha (up to RM 67) was the primary factor limiting chinook spawning and egg incubation success. Losses of appropriate sized substrate have resulted from upstream channel simplification and bank armoring caused by "stream cleaning" and land use activities (Ashe et al. 2000).

Recent improvements, such as livestock exclosures and woody debris reintroduction by the USFS, have improved gravel accrual rates in the mainstem Imnaha River (Ashe et al. 2000). By the mid-1990s, reaches of the Imnaha upstream of the national forest boundary were considered to have sufficient amounts of woody material, and had gravel bars beginning to form behind logjams. Spawning and incubation conditions were considered to be good to excellent in the upper Imnaha (Ashe et al. 2000).

Spring/summer chinook spawning and incubation life history phases are limited in the upper half of Big Sheep Creek (Mobrand and Lestelle 1997). Although the quantity of spawning and incubation habitat in Big Sheep Creek is comparatively small, losses over time have been substantial (Mobrand and Lestelle 1997). Factors contributing to these declines include changes in water temperature regimes, channel stability, habitat diversity, and, to a lesser extent, flow regimes and sediment load (Mobrand and Lestelle 1997). The USFS (1998b) found that stream temperatures were slightly below environmental potential (at risk) throughout much of the Big Sheep Creek drainage, although the analysis was focusing on summer steelhead. High water temperatures and low water levels prevent Little Sheep Creek from being suitable chinook spawning habitat (NMFS 2001). Ashe (et al. 2000) summarizes chinook spawning and rearing conditions in the Big Sheep Creek watershed as “fair to excellent in the upper watershed above Coyote Creek (RM 20.4) and fair to poor below Coyote Creek”.

Growth and Feeding

Spring/summer chinook fry colonization and summer rearing life history stages have been reduced from historical levels in the middle to lower reaches of the Imnaha (Mobrand and Lestelle 1997). Habitat conditions that support these particular stages have been compromised by increased water temperatures, small losses in habitat diversity, and increased channel instability (Mobrand and Lestelle 1997). Ashe (et al. 2000) does not consider these losses to significantly threaten chinook production, however, and rates colonization and summer rearing in the Imnaha as “good to excellent”.

In Big Sheep Creek, fry colonization and summer rearing life history stages have been reduced through losses of habitat diversity, elevated temperatures, predators, competitors, flows and sediment loads in the lower 35 stream miles (Mobrand and Lestelle 1997). Colonization and summer rearing life history stages in Little Sheep Creek are not identified as limited since chinook production in the drainage has likely never been significant in relation to the rest of the subbasin (Mobrand and Lestelle 1997). Ashe (et al. 2000) rates colonization and summer rearing conditions as “good to excellent above Coyote Creek (RM 20.4) and fair to poor below Coyote Creek”.

Overwintering survival in the upper Imnaha may be reduced due to anchor ice formation or ice floes (NPPC 1990, Ashe et al. 2000). Ashe (et al. 2000) defines fall redistribution and overwintering life history phases of chinook salmon to range from good to excellent in the lower Imnaha, and fair to good in the upper Imnaha, based on temperatures.

Fall redistribution and overwintering life history stages of chinook may be limited in the lower portion of Big Sheep Creek due to land use activities and the presence of a channel-confining road (Big Sheep Creek Road) (Gaumer 1968). Conditions for fall redistribution and overwintering of spring/summer chinook are considered to be fair to excellent from the 3900 Road bridge to the mouth (Ashe et al. 2000).

1.5.1.2 Local Limiting Factors–Fall Chinook

Primary factors limiting fall chinook production in the Imnaha include fine sediment, low flow, and poor habitat diversity. Because fall chinook are present only in the mainstem below the town of Imnaha, the factors limiting them are focused exclusively in this area.

Migration—Adult and Juvenile

Immigration of adult fall chinook into the Imnaha subbasin occurs during a time of the year when water temperatures are dropping and base flows are increasing (October through the end of November). It is therefore reasonable to assume that flows and temperatures do not represent a limiting factor to this life history stage.

Outmigration of subyearlings from the Imnaha subbasin is also coincident with a period of favorable flow and reduced stream temperatures (end of May through the first half of July), and is therefore not likely to be limited by in-subbasin factors. Factors limiting downstream migration of Imnaha fall chinook are more commonly associated with riverine conditions in the mainstem Snake River.

Reservoir heating of water in upriver pools during summer months and its subsequent release out of Hells Canyon Dam likely contribute to documented higher water temperatures above the confluence of the Salmon River (Rondorf and Tiffan 1996). These temperatures may exacerbate fall chinook immigration and spawning delays, while accelerating egg incubation and juvenile emigration (Rondorf and Tiffan 1996). Consequently, the fish from the Snake Hells Canyon subbasin arrive at Lower Granite Dam, on average, up to four weeks later than they did before development of the Hells Canyon Complex and the U.S. Army Corps of Engineers' four lower Snake River projects (NMFS 2000a). Johnson and Stangl (BLM 2000a) found that fall chinook fry emerging later than mid-May may not be large enough to begin their downstream migration as age 0 fish. Delays in chinook outmigration may also occur due to slack-water impoundments (i.e., upper pool of Lower Granite Dam). Combined, the delays place juvenile migrants in reservoirs during periods when water temperatures approach chinook salmon's thermal tolerance (NMFS 2000a).

Studies examining smoltification timing suggest that the protracted emigration exhibited by Snake Hells Canyon subbasin fall chinook may confer a survival disadvantage to downstream migration life history phases (Rondorf and Tiffan 1997). Gill ATPase followed a trend of increasing activity until late June, then a decline throughout the remainder of the summer (Rondorf and Tiffan 1997). Similarly, subyearling chinook exhibited the most net downstream movement at velocities of 6 to 18 inches per second early in the season, and less movement as the season progressed. This delay often places late arriving fall chinook in unsuitable reservoir environments, and may increase their susceptibility to predation.

Spawning and Incubation

Limiting factors to fall chinook spawning in the Imnaha are not well documented. It is possible that fine sediment may be limiting substrate availability and may partially be responsible for the change in the reported distribution of fish; however, specific habitat limitations from fines is currently unknown. The fact that fall chinook inhabit depositional reaches in the Imnaha requires restoration efforts to be directed to upriver or upland sources rather than in the specific reaches used by the fish.

Because of their ESA listing, little applied research has been conducted regarding the incubation life history stage of fall chinook in the Imnaha subbasin. Methods used to define habitat and water quality criteria relative to incubation life history stages generally require unnecessary and unacceptable levels of direct "take" (in the form of mortality) and are prohibited under the ESA. It is therefore reasonable to use surrogate measures such as laboratory experiments or sedimentation indices to define criteria for incubation life history stages of fall chinook. Empirical data suggest that fine sediments (<6.4 mm) that comprise 20 to 25% of the redd substrate will have a deleterious effect on incubation success (Eaton and Bennett 1996), including a reduction in the porosity of the redd. The less porous redd will consequently have a reduced intragravel water velocity which will in turn affect oxygen delivery to developing embryos and removal of metabolic wastes. Eaton and Bennett (1996) found that Snake River fall chinook survival to emergence (STE) was not significantly impaired by low water velocity, and that successful STE occurred when velocities were at least 0.3 centimeters per second. Early or premature emergence has been documented when oxygen concentrations within the redd are unsuitable (Alderice et al. 1958) or when water temperatures become warm.

In their biological assessment, the USFS defines fine sediment in the lower Imnaha to be "functioning at risk". Whether the concentrations are at a level (i.e., comprising 20–25% of the redd) that is detrimental to fall chinook incubation success is unknown.

Some have suggested that excessively low winter temperatures may limit embryonic development of Imnaha fall chinook and consequently reduce production (Mundy and Witty 1998), although supporting data are limited. Mundy and Witty (1998) also contend that fall chinook embryos may be limited by severe and massive ice floes common to the Imnaha, which could potentially disrupt redds and dislodge eggs.

Growth and Feeding

Since the majority of fall chinook growth and feeding occurs out of the Imnaha subbasin, in-basin factors limiting this particular life stage are negligible. Mundy and Witty (1998) suggest that juvenile fish may be swept out of the system during unnaturally elevated spring streamflows; however, this theory is also speculative and currently unfounded.

1.5.1.3 Local Limiting Factors–Steelhead

Primary factors limiting summer steelhead in the Imnaha River include high stream temperatures, poor riparian condition, high flows, excessive fine sediment, low flows and low/limited adult escapement or low population size. These problems are most significant in the Big Sheep Creek watershed. Low/limited adult escapement or low population size represent a subbasin-wide limiting factor. A textual discussion of limiting factors specific to life stage is provided below.

Migration—Adult and Juvenile

Migration of adult steelhead into the subbasin and to their spawning grounds does not appear to be significantly limited by the habitat attributes defined in the QHA modeling process. High stream temperatures, a factor that may modify spawn timing, may be a problem during some years, but do not appear directly attributable to population declines. Riparian condition, high flows, and sediment are all rated "low" (based on QHA ratings) relative to the importance they have on migration life history stages. Low flows are rated high in terms of their influence on migration, and may limit adults access to certain spawning habitats. The USFS (1998b) suggests that low flows may limit rearing and spawning in Big Sheep Creek; however, due to their spawn timing (April through mid-June) it is likely that flows would be sufficient for steelhead spawning success during most years.

Since juvenile steelhead outmigration timing (early April through mid-June) generally coincides with periods of high flow and reduced temperatures, smolt migration life history stages are for the most part not limiting population persistence.

Spawning and Incubation

In the Big Sheep Creek watershed, steelhead spawning and incubation life history stages are most susceptible to excessively high flows, and fine sediment.

Modification of upland vegetation through the Canal Fire (1989), Twin Lake Fire (1994), timber harvest, windstorms, and insect outbreaks have changed runoff characteristics in portions of the drainage, based on flow characteristics of the gaging station at the town of Imnaha (USFS 1998b). High flows, combined snow avalanches and debris flows, occur frequently in the geomorphologically young Big Sheep and Little Sheep Creek systems (USFS 1995), and may be responsible for causing changes to spawning substrate availability and/or disrupt or dislodge steelhead incubating in redds.

Changes to upland vegetation have also accelerated sheet and rill erosion in five subwatersheds within the Big Sheep Creek drainage, and has caused gully erosion to increase in three subwatersheds (USFS 1998b). The increases in fine sediment may be compromising the integrity of steelhead redds and/or emergence success of steelhead fry. Management activities have also introduced sediment into the channel systems. Overall, sediment availability and transport is above environmental potential in these subwatersheds and has been classified as “functioning at risk”.

Sediment availability and rerouting has been altered by private land influences on Big Sheep Creek (RM 31.9), and lower and middle Little Sheep Creek (predominately livestock grazing, rural home sites, and pasture creation) (USFS 2003d). Although increased sediment deposition in low-gradient reaches has been noted, the removal of the hydropower facility on Little Sheep Creek in 1997 is suspected to flush a proportionate amount of stored sediment during spring runoff (USFS 1998b, NMFS 2001).

Water temperatures, turbidity/sediment, substrate and peak/base flows are considered to be either at risk or not properly functioning within portions of Little Sheep Creek (NMFS 2001), and may limit steelhead spawning and incubation life history stages. Areas with sufficient amounts of temperature-ameliorating vegetation are present in some portions of Little Sheep Creek, but are limited in others, mainly due to the presence of the adjacent highway and livestock encroachment on the riparian area.

Steelhead spawning and incubation life history phases below Nine Points Creek on the mainstem Imnaha may be limited by unstable cobble and gravel bars, which resulted from excessively high amounts of bedload movement caused by storm events in 1992 and 1997 (USFS 1998a). Some perennial headwater streams that feed the upper Imnaha may not be suitable for steelhead spawning and incubation due to high amounts of fine sediment produced through various land management activities and natural erosion patterns (USFS 1998a); however, the majority of these streams are in a condition suitable to support spawning and rearing life history stages. The primary factors considered to affect steelhead spawning and rearing habitat are the livestock allotments and roads in mid-elevation areas on the Forest (B. Knox, ODFW, personal communication, May 2001).

Growth and Feeding

The majority of the fry colonization and early rearing of summer steelhead occurs in the tributaries to the Imnaha, and not the mainstem. The condition of tributary habitat is sufficient in most cases to support early life history forms of steelhead. High stream temperatures do occur in some areas, albeit for a short period of time during a given day, and do not preclude rearing of summer steelhead. The periodic warming does, however, contribute to cumulative impacts to downstream reaches.

Cultivation, farming, and pasturing have reduced the riparian component, specifically the cottonwood communities, resulting in an "at risk" rating (USFS 1998a). The lack of woody material input to the stream channel in these areas has simplified the system both hydrologically and biologically. In an effort to address large organic debris (LOD) deficiencies, the Wallowa-Whitman National Forest has completed bioengineering work along 3 stream miles, where woody material was anchored to the streambank (i.e., hard structures), and has completed work along 13 stream miles, in which woody material was merely reintroduced to the channel (i.e., soft structures) (J. Platz, Wallowa-Whitman National Forest, personal communication, May 2001).

Because steelhead fry colonization and summer rearing life history stages are largely reliant upon diverse, sufficiently deep, cool and productive habitat types (Bjornn and Reiser 1991), the lack of these elements in the lower portions of the Big and Little Sheep Creek drainages may pose a limiting factor to production. The USFS (1998b) defines large woody material throughout lower Big Sheep Creek and lower and middle Little Sheep Creek to be below natural potential ("at risk") based on PACFISH guidelines and NMFS habitat matrices. A combination of natural landscape characteristics and riparian habitat modification has contributed to the rating. Similarly, pool quality and frequency were rated as "at risk" and did not meet PACFISH guidelines or NMFS criteria for anadromous habitat; the ratings, however, excluded pocket pools, which often comprised up to 30% of the channel (USFS 1998b). Nevertheless, pool frequency, pool quality, large organic matter, streamflow and stream temperatures, are generally least favorable for summer steelhead colonization and summer rearing life history stages in the lower-elevation reaches of the Big Sheep Creek drainage.

The primary constraints to fall redistribution and overwintering life history stages of steelhead in the mainstem Imnaha are related to habitat availability and flow. Similar to summer rearing life history phases, overwintering juvenile steelhead require relatively complex habitat types, like those often provided by in-channel organic debris (Bjornn and Reiser 1991). In select areas where riparian reserves have been altered, such as along private lands bordering some of the lower mainstem reaches or along channels modified through riprapped banks, dredging, and elimination of off-channel refugia (USFS 1998a), the diversity of overwintering habitat has been reduced or eliminated, and hence has constrained the potential productivity of these life history phases. The elimination of riparian reserves and their inherent insulation capacity combined with wintertime base flows may also restrict overwintering success, since stream temperatures may become low enough to freeze and/or for anchor ice to form.

Adult and juvenile steelhead that utilize Big and Little Sheep Creek during winter months—December through February—are subject to a reduction in available habitat due to anchor ice buildup and ice floes (USFS 1998b). Icing conditions in the smaller perennial tributaries are prevalent throughout the watershed because of low flow conditions.

1.5.1.4 Local Limiting Factors–Bull Trout

High temperatures, low flow, fine sediment, obstructions, and high flows are identified as key habitat attributes that have been impacted and are subsequently limiting bull trout populations throughout the subbasin. Agriculture, forest management practices, and livestock grazing are considered to be primary factors acting to modify habitat conditions (USFWS 2002b).

Migration—Adult and Juvenile

The fluvial and resident forms of bull trout that reside in the Imnaha rely on an unobstructed path both to and from spawning, rearing, and overwintering areas. Seasonal migration barriers, including periods of reduced water quality (i.e., high summer stream temperatures), insufficient flows and/or degraded habitat pose a potential threat to bull trout connectivity between neighboring subpopulations in the Imnaha River and Sheep Creek (USFS 2000).

The construction and operation of irrigation diversions in the Big Sheep Creek watershed has contributed to the decline of bull trout populations by restricting passage, reducing streamflow, and causing increases in summer water temperatures. The diversions that exist in association with the Wallowa Valley Improvement Canal have created physical barriers to migrating bull trout in Big Sheep, Little Sheep, and McCully Creeks. For example, the diversion at McCully Creek has effectively isolated bull trout since the 1880s (Buchanan et al. 1997). The loss of connectivity prevents genetic interchange and refounding potential between bull trout populations above and below the diversions, and because the diversions aren't screened, some bull trout have become entrapped in the canal causing high mortality in some cases (USFWS 2002b).

Irrigation diversions also act to remove potential Big Sheep Creek streamflow into the canal, which carries the water out of the Imnaha subbasin and into the Grande Ronde subbasin (Wallowa Valley). The loss of streamflow during naturally low flow periods contributes to the already high stream temperatures that have been exacerbated by the loss of vegetation through the Canal Fire (1989), Twin Lake Fire (1994), timber harvest, windstorms, and insect outbreaks. Similarly, the low flows that result from irrigation withdrawals can prevent bull trout, which are preparing to spawn, from accessing spawning grounds, and in some cases can strand migrants (USFWS 2002b).

Spawning and Incubation

Spawning and incubation habitat in Big Sheep Creek has been impacted from the Wallowa Valley Improvement Canal, sediment caused by land use activities and vegetation losses, livestock grazing, and nonpoint pollution. A relationship between habitat impacts and the spawning/incubation success of bull trout has not, however, been established (Buchanan et al. 1997).

A primary limitation to bull trout spawning and incubation life history stages in the Big Sheep Creek watershed is a reduction in streamflow caused by irrigation withdrawals. The loss of streamflow during naturally low flow periods contributes to elevated water temperatures that can delay spawning. A delay in spawning may result in late emergence of fry from the gravel, which would result in the juvenile being smaller than fish that had emerged earlier, which may ultimately confer a survival disadvantage during later life history stages (i.e., the smaller fish would be more susceptible to predation and may not successfully overwinter).

Livestock use affects habitat between Owl Creek and Lick Creek (Big Sheep Creek watershed) and in the lower several kilometers of Lick Creek. Overutilization of streamside vegetation contributes to high stream temperatures and sedimentation problems in these and other portions of the subbasin. Similar to other salmonid species, excessive fine sediments in bull trout redds reduce incubation and emergence success. Significant livestock grazing (as well as some feedlot development) also exists in the lower portion of Little Sheep Creek and may cause direct mortality of eggs or alevin if the redd (spawning bed) is trampled during watering or crossing (USFWS 2002b).

Growth and Feeding

Juvenile life history stages of bull trout that utilize the mainstem Imnaha (most known summer rearing and holding areas in the Imnaha River are on National Forest or wilderness lands above Summit Creek) are limited by high stream temperatures, fine sediment, channel instability, and streamflow extremes (excessively high and low spring and summer flows, respectively). Juveniles occurring in Big Sheep Creek (the majority of summer rearing appears to occur above RM 31 near Owl Creek [Buchanan et al. 1997]) are mainly limited by high stream temperatures and streamflow extremes. Juveniles occurring in Little Sheep Creek (the majority of summer rearing appears to occur above the canal diversion at approximately RM 25.5 (Buchanan et al. 1997)) are limited by high stream temperatures, fine sediment, and obstructions. Primary limiting factors to juvenile bull trout occurring in McCully Creek (summer rearing occurs throughout the creek, particularly in National Forest and Wilderness areas (Buchanan et al. 1997) include fine sediment and obstructions.

Because juvenile bull trout rearing habitat in the mainstem Imnaha is primarily associated with areas not influenced by private land ownership, activities, and processes on USFS-managed lands can be attributed to habitat losses. Forest management practices and livestock grazing in the mainstem (above Summit Creek) have acted cumulatively with the inherently unstable granitic geology in this area to contribute excessive fine sediment to the stream channel. Because of the reduced size and competence of the river to transport sediment, portions of the channel have attained unsuitable width: depth ratios, which have acted to create a shallow and wide system in places (USFWS 2002b). Stream channels with this morphology will typically exhibit higher stream temperatures than a narrower and deeper channel, which may force bull trout to seek out cool water refugia, thereby limiting potential feeding efficiency and growth.

Similar to the mainstem Imnaha, most juvenile rearing in Big Sheep Creek occurs in a portion of the watershed that is managed by the Wallowa Whitman National Forest, and is therefore less subjected to the effects associated with private land ownership. Streamflow extremes and high temperatures are most commonly associated with changes in upland and riparian vegetation, which in this portion of the watershed, have occurred from natural and anthropogenic influences. Agricultural clearing (for example, Big Sheep Creek between the forest boundary and Coyote Creek), loss of woody debris from campground development (for example, Lick Creek), and harvest-related wildfire have decreased the function of the existing riparian vegetation in many areas (USFWS 2002b).

In Little Sheep Creek, bull trout feeding and growth are directly and indirectly affected by agricultural practices (i.e., irrigation withdrawals) and livestock grazing. Diversion of streamflows for irrigation purposes have contributed to high stream temperatures and directly influence foraging opportunities by preventing access to potentially usable habitats and/or by stranding juvenile fish in dry channel beds (USFWS 2002b). Indirect effects of irrigation withdrawals in Little Sheep Creek include those associated with reductions in water quality. When irrigation water is returned to streams and rivers, it carries sediment and nonpoint pollution from agricultural chemicals which may degrade water quality (USFWS 2002b). Specific concerns include, but are not limited to, much of the Little Sheep Creek watershed, which has water withdrawals that reduce summer and fall flows in the upper reaches of the system (USFS 2001).

Barriers resulting from irrigation diversions are largely responsible for limiting bull trout growth and feeding in McCully Creek. As mentioned previously, the McCully Creek subpopulation of bull trout has been effectively isolated from the rest of the subbasin since the late 1880s. This isolation limits potential feeding and growth opportunities by restricting bull trout to rely exclusively upon available resources within the subwatershed or within the canal itself. And while fish may occasionally “spill” downstream, fish cannot pass upstream of the diversion (USFWS 2002b). Fish movement down the canal is probably limited, at least seasonally, by poor water quality conditions and warm water temperatures that would force fish back into McCully Creek (USFWS 2002b).

1.5.1.5 QHA-Based Limiting Factors Analysis

Qualitative Habitat Assessment (QHA; Mobrand Biometrics 2003b) was used to evaluate habitat conditions within and between sixth field HUCs for spring chinook, fall chinook, steelhead, and bull trout in the Imnaha subbasin. Analyses were run based on the habitat occupied[7] for each species (Table 89; Figure 67).

[7] Habitat occupation included consideration of four life history stages, as defined by Mobrand Biometrics (2003b). These were spawning and incubation, summer rearing, winter rearing, and migration.

Raw data used in, and outputs from the QHA model are included in Appendix O. Information included in this section is not a direct reflection of those results. Adjustment was made to QHA restoration scores/ranks to account for relevant factors not considered within the QHA model itself (e.g. amount of available habitat and current management). No adjustment was made to original QHA protection scores/ranks.

To account for the differing amount of habitat between HUCs (*e.g.,* total stream miles in a sixth field HUC used by a given species), QHA restoration scores were standardized based on the average usable length of stream in the subbasin (Table 89). The estimated length utilized within each individual HUC was divided by the subbasin average; the result was then multiplied by the original QHA restoration score for that reach. The streams were re-ranked according to the resultant scores.

Table 89. Average stream miles per sixth field HUC occupied by spring chinook, fall chinook, steelhead, and bull trout in the Imnaha subbasin. Averages were used to standardize restoration scores derived from QHA modeling efforts.

Species	Total # of HUCs Occupied	Average Miles Occupied per HUC	Range (Miles)		Standard Deviation
			Minimum	Maximum	
Spring Chinook	28	5.4	0.8	12.9	3.38
Fall Chinook	4	4.5	1.4	7.2	2.46
Steelhead	46	7.8	2.2	13.5	3.40
Bull Trout	23	8.3	2.4	15.4	3.60

The QHA restoration scores were also adjusted by factoring in the conservation protection status occurring within the immediate floodplain. The aquatics technical team agreed that an effective restoration program should adhere to basic conservation biology concepts, such as building out from areas that are offered some degree of protection. It was assumed that the protection status occurring within a 100-foot buffer zone of the stream channel would most accurately characterize aquatic ecosystem response to management activities. The protection status of the 100-foot buffer zone was derived from land management layers based on GAP designations and included four levels with essentially two degrees of protection; Levels 1 and 2 are lands managed for natural values, whereas Levels 3 and 4 are lands with no special protection. The dominant protection status in the HUC was calculated based on 25% increments (*e.g.,* ≥75% of buffer in Levels 1 or 2 received a score of 1; 50-75% of buffer in Levels 1 or 2 received a score of 2; 25-50% in Levels 1 or 2 received a score of 3; ≤25% in Levels 1 or 2 received a score of 4). Protection status scores were then used to sort the revised restoration score to arrive at a restoration prioritization schedule (Table 90).

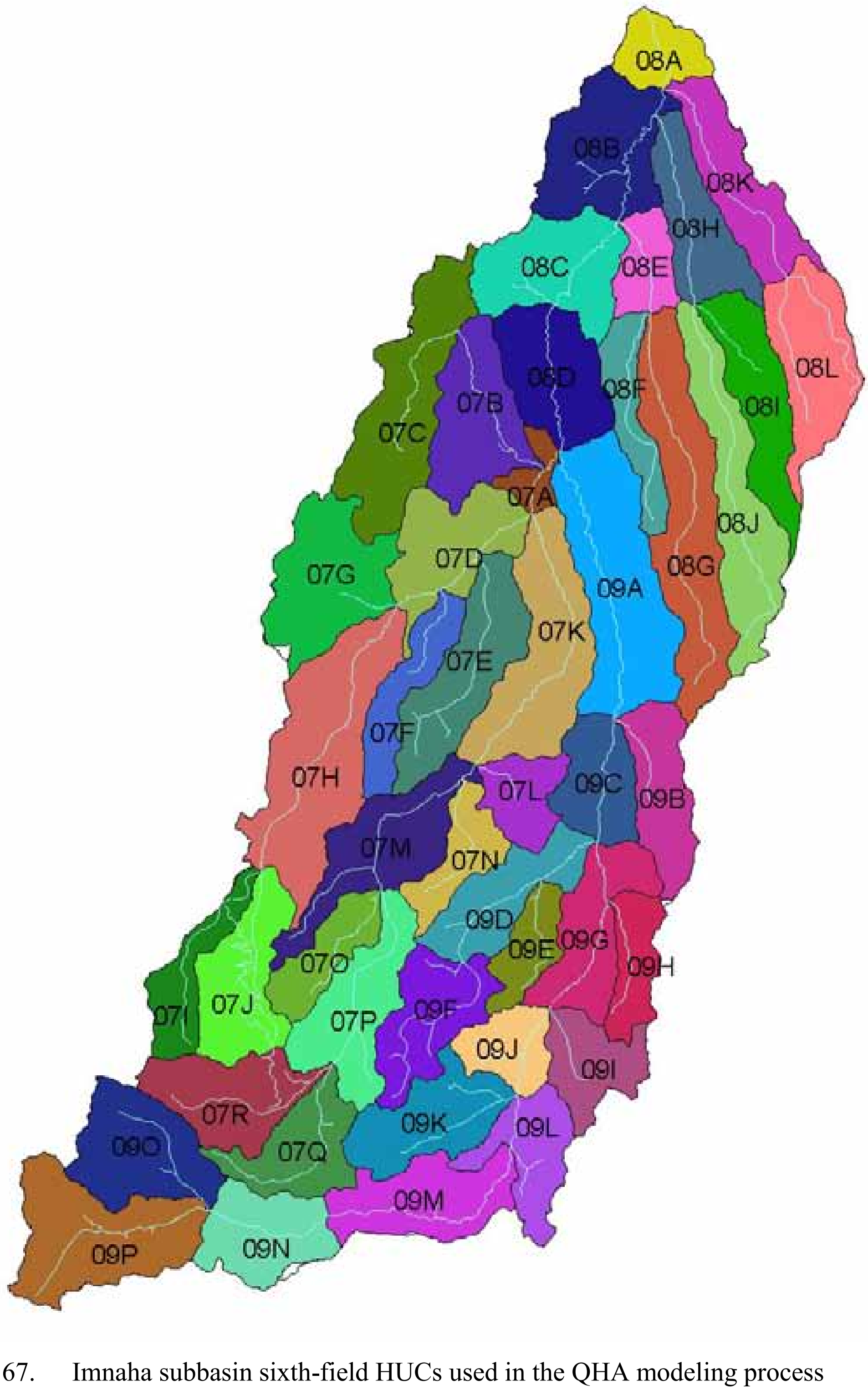

Figure 67. Imnaha subbasin sixth-field HUCs used in the QHA modeling process

Table 90. Conservation protection status of 100-foot buffer zones in each of the 43 sixth field HUCs in the Imnaha subbasin. A score of 1 or 2 ('High') indicates the dominance of conservation-based management, whereas a score of 3 or 4 ('Low') indicates that the buffer zone receives no special protection.

HUC_6	% protected	Buffer Protection Rating	Score
07A	0.0	Low	4.0
07B	86.2	High	1.0
07C	94.5	High	1.0
07D	7.8	Low	4.0
07E	0.0	Low	4.0
07F	61.1	High	2.0
07G	0.0	Low	4.0
07H	0.0	Low	4.0
07I	46.1	Low	3.0
07J	6.9	Low	4.0
07K	0.0	Low	4.0
07L	24.8	Low	4.0
07M	0.0	Low	4.0
07N	19.4	Low	4.0
07O	33.7	Low	3.0
07P	14.4	Low	4.0
07Q	79.2	High	1.0
07R	48.3	Low	3.0
08A	75.7	High	1.0
08B	33.3	Low	3.0
08C	16.1	Low	4.0
08D	0.0	Low	4.0
08E	13.7	Low	4.0
08F	86.3	High	1.0
08G	92.7	High	1.0
08H	17.8	Low	4.0
08I	100.0	High	1.0
08J	100.0	High	1.0
08K	53.3	High	2.0
08L	100.0	High	1.0
09A	10.5	Low	4.0
09B	47.4	Low	3.0
09C	4.2	Low	4.0
09D	8.1	Low	4.0
09E	9.0	Low	4.0
09F	2.0	Low	4.0
09G	5.8	Low	4.0
09H	85.0	High	1.0
09I	96.9	High	1.0
09J	92.6	High	1.0
09K	100.0	High	1.0
09L	100.0	High	1.0
09M	100.0	High	1.0
09N	100.0	High	1.0
09O	100.0	High	1.0
09P	100.0	High	1.0

No adjustment was made to original QHA protection scores/ranks. Protection of both larger and smaller habitat areas used by focal species will be critical to maintaining population/habitat diversity, irregardless of reach length. This concept is consistent with the guiding principles of the accompanying subbasin management plan and with the scientific principles of the Council's Fish and Wildlife Program (NPPC 2000).

Species-specific comparisons of protection versus (adjusted) restoration ranks for each sixth-field HUC are shown in Table 91, Table 94, Table 97, and Table 100. A graphical representation of restoration *vs.* protection areas for each species follows the respective tables (Figure 68,Figure 69, Figure 70, and Figure 71).

Reaches prioritized for restoration activities are presented in rank order in Table 92, Table 95, Table 98, and Table 101; those prioritized for protection are presented in rank order in Table 93, Table 96, Table 99, and Table 102. In each of these tables, habitat priority factors in need of restoration or protection (respectively) are highlighted using rankings drawn directly from the QHA model outputs[8] (See Appendix O.

Table 91. Comparative restoration versus protection value for spring chinook sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.

Protection Rank / **Restoration Rank**[1]	**High**	**Moderate**	**Low**
High (Note: Cells in this row have streams listed in order of Restoration Rank)	**Priority = <u>Restore</u>** 09G Imnaha River 6 07M Big Sheep Creek	**<u>Priority = Restore</u>** 07K Big Sheep Creek 1 07P Big Sheep Creek 3 08K Cow Creek	**<u>Priority = Restore</u>** 09A Imnaha River 08D Imnaha River 3 (town) 07D Little Sheep Creek 1 08B Imnaha River
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	**Priority = <u>Protect</u>** 09M Imnaha River 09J Imnaha River 07R Big Sheep Creek Headwaters 09N Imnaha River 07Q Lick Creek 1	**Priority =** **<u>Protect & Restore</u>** 08H Lightning Creek 09C Imnaha River	**<u>Priority = Restore</u>** 08C Imnaha River 2 07A Big Sheep Creek 08E Horse Creek
Low (Note: Cells in this row have streams listed in order of Protection Rank)	**<u>Priority = Protect</u>** 09P South Fork Imnaha River 1 09L Imnaha River	**<u>Priority = Protect</u>** 09D Grouse Creek 1 07B Camp Creek 1 08A Imnaha River 09B Freezeout Creek 1 09I Crazyman Creek 1	**<u>Priority = Protect</u>** 09H Summit Creek 1 07E Bear Gulch

[8] Within QHA a maximum of eleven ranks are possible within each reach (one for each habitat variable). Due to tie rankings, the number of unique ranks observed in any reach considered in this assessment did not exceed 6. To extract only priority information from the QHA matrix, the following rules were applied in creating Table 2 and Table 3: If 2-3 unique ranks existed for a given reach, the single most important issue is highlighted in summary tables; If 4-6 unique ranks existed for a reach, the two most important issues are highlighted in summary tables. Ranks are taken directly from the QHA model output and are comparable within but not between rows/reaches.

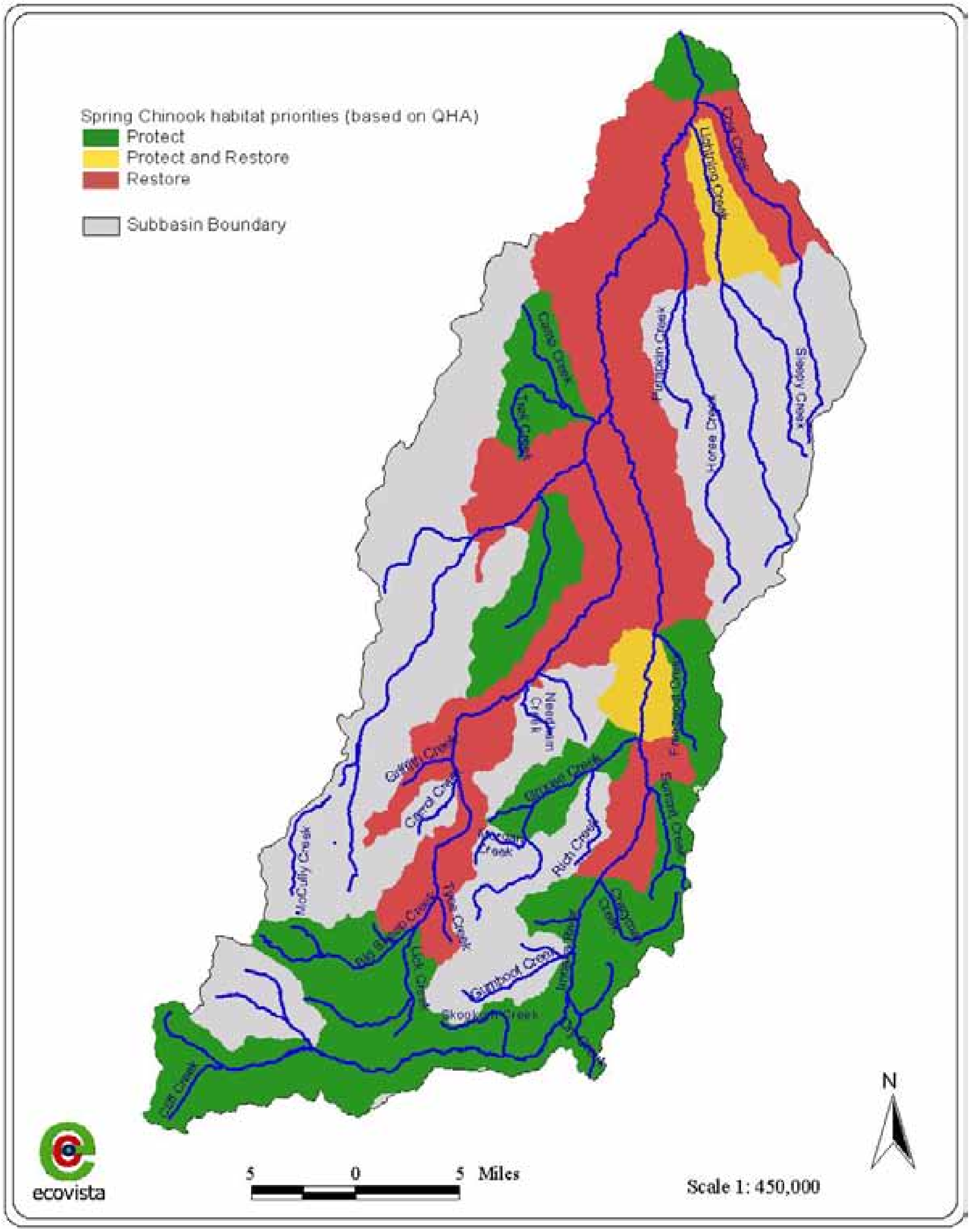

Figure 68. QHA-based restoration and protection areas for spring chinook in the Imnaha subbasin

Table 92. Restoration ranks[1] for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name[2]	Length (Miles)[3]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	07K Big Sheep Creek 1	12.9		3				2			1		
2	09A Imnaha River	12.7			3			2			1		
3	09G Imnaha River 6*	8.2			3	2					1		
4	07P Big Sheep Creek 3	8.5	4			3		1			1		
5	08D Imnaha River 3 (town)	6.5			3			2			1		
6	07M Big Sheep Creek*	8.2	3				4	1			1		
7	07D Little Sheep Creek 1	4.8			3			2			1		
8	08K Cow Creek	10.3			2		3	3			1		
9	08B Imnaha River	7.2	3			2					1		
10	08C Imnaha River 2	5.4				2		3			1		
11	09J Imnaha River	4.0			3						1		2
12	09M Imnaha River	8.0		3		3		1			1		
13	07R Big Sheep Creek Headwaters	3.2				2	3	1					
13	08H Lightning Creek*	8.3			1		2	2			2		
15	07A Big Sheep Creek	3.2				2		3			1		
15	07Q Lick Creek 1	3.4	3	2				1					
17	08E Horse Creek	4.4			4	3		1			1		
17	09N Imnaha River	5.7		3		3		1			1		
19	09C Imnaha River*	5.8			2						1		
20	08A Imnaha River	3.8			2			3			1		
20	09D Grouse Creek 1	1.1	4					1			1		3
22	07B Camp Creek 1	1.7			2	2		1					
23	07E Bear Gulch*	5.4	1		3						1		
23	09H Summit Creek 1*	1.5	3	3	3	3		1			1		
23	09L Imnaha River	2.4		3		3		1			1		
26	09P South Fork Imnaha River 1	1.5		3		3		1			1		
27	09I Crazyman Creek 1	1.1					2	2			1		
28	09B Freezeout Creek 1	0.8					2	2			1		

1/ Uses 'adjusted' reach ranks (previously described) to give weight to amount of usable habitat (stream length)
2/ HUCs prioritized as "Protect and Restore" in Table 91 are included in both Table 92 and Table 93 and are marked with and asterisk (*)
3/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which spring chinook use for either spawning/incubation, summer/winter rearing, or migration has been defined (ODFW data)

Table 93. Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Protection Rank	Reach Name[1]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	09M Imnaha River						3				2	1
1	09P South Fork Imnaha River 1	3	3							2	1	
3	09L Imnaha River						3				1	2
3	09N Imnaha River		1		1		1				1	
5	09J Imnaha River				2						1	3
6	09G Imnaha River 6*		1		1						3	
7	07R Big Sheep Creek Headwaters		1	3							2	
8	07Q Lick Creek 1				2					1	3	
9	07M Big Sheep Creek*			3						1	2	
10	09D Grouse Creek 1	2	2		2		1					2
11	07P Big Sheep Creek 3						1				3	2
12	07B Camp Creek 1						1				3	2
13	07K Big Sheep Creek 1						3				2	1
14	08A Imnaha River	3	3								2	1
15	08H Lightning Creek*						1			1		3
16	09B Freezeout Creek 1						1				3	2
16	09I Crazyman Creek 1						3				2	1
18	08K Cow Creek						1				3	2
19	09C Imnaha River*						1				3	2
20	07D Little Sheep Creek 1		1	3	1						4	
21	08E Horse Creek		2				1				3	
22	08C Imnaha River 2									3	2	1
23	08B Imnaha River						1				3	2
24	08D Imnaha River 3 (town)		2		2		1					
25	09H Summit Creek 1*		4		4		1			1		
26	07A Big Sheep Creek		4		4		1			1	3	
27	09A Imnaha River		4		4		1			1	3	
28	07E Bear Gulch*		4		4		1			1	3	

[1]/ HUCs prioritized as “Protect and Restore” in Table 91 are included in both Table 92 and Table 93 and are marked with and asterisk (*)

Table 94. Comparative restoration versus protection values for fall chinook sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.

Protection Rank / Restoration Rank[1]	High	Moderate	Low
High	**Priority = <u>Restore</u>**	**<u>Priority = Restore</u>** 08B Imnaha River	**<u>Priority = Restore</u>**
Moderate	**Priority = <u>Protect</u>** 08A Imnaha River	**Priority =** **<u>Protect & Restore</u>** 08C Imnaha River 2	**<u>Priority = Restore</u>**
Low	**<u>Priority = Protect</u>**	**<u>Priority = Protect</u>**	**<u>Priority = Protect</u>** 08D Imnaha River 3 (town)

Table 95. Restoration ranks[1] for sixth code HUCs and habitat variables within each, for HUCs occupied by fall chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name[2]	Length (Miles)[3]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	08B Imnaha River	7.2			2			1			3		
2	08C Imnaha River 2*	5.4			3	1		2					
3	08A Imnaha River	3.8				1	3	2					
4	08D Imnaha River 3 (town)*	1.4				3	2	1					

[1]/ Uses 'adjusted' reach ranks (previously described) to give weight to amount of usable habitat (stream length)
[2]/ HUCs prioritized as "Protect and Restore" in Table 94 are included in both Table 95 and Table 96 and are marked with and asterisk (*)
[3]/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which fall chinook use for either spawning/incubation, summer/winter rearing, or migration has been defined (ODFW data)

Table 96. Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by spring chinook within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Protection Rank	Reach Name[1]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	08A Imnaha River					3	2				1	
2	08B Imnaha River					3	2				1	
3	08C Imnaha River 2*					3	2				1	
4	08D Imnaha River 3 (town)*					3	2				1	

[1]/ HUCs prioritized as "Protect and Restore" in Table 94 are included in both Table 95 and Table 96 and are marked with and asterisk (*)

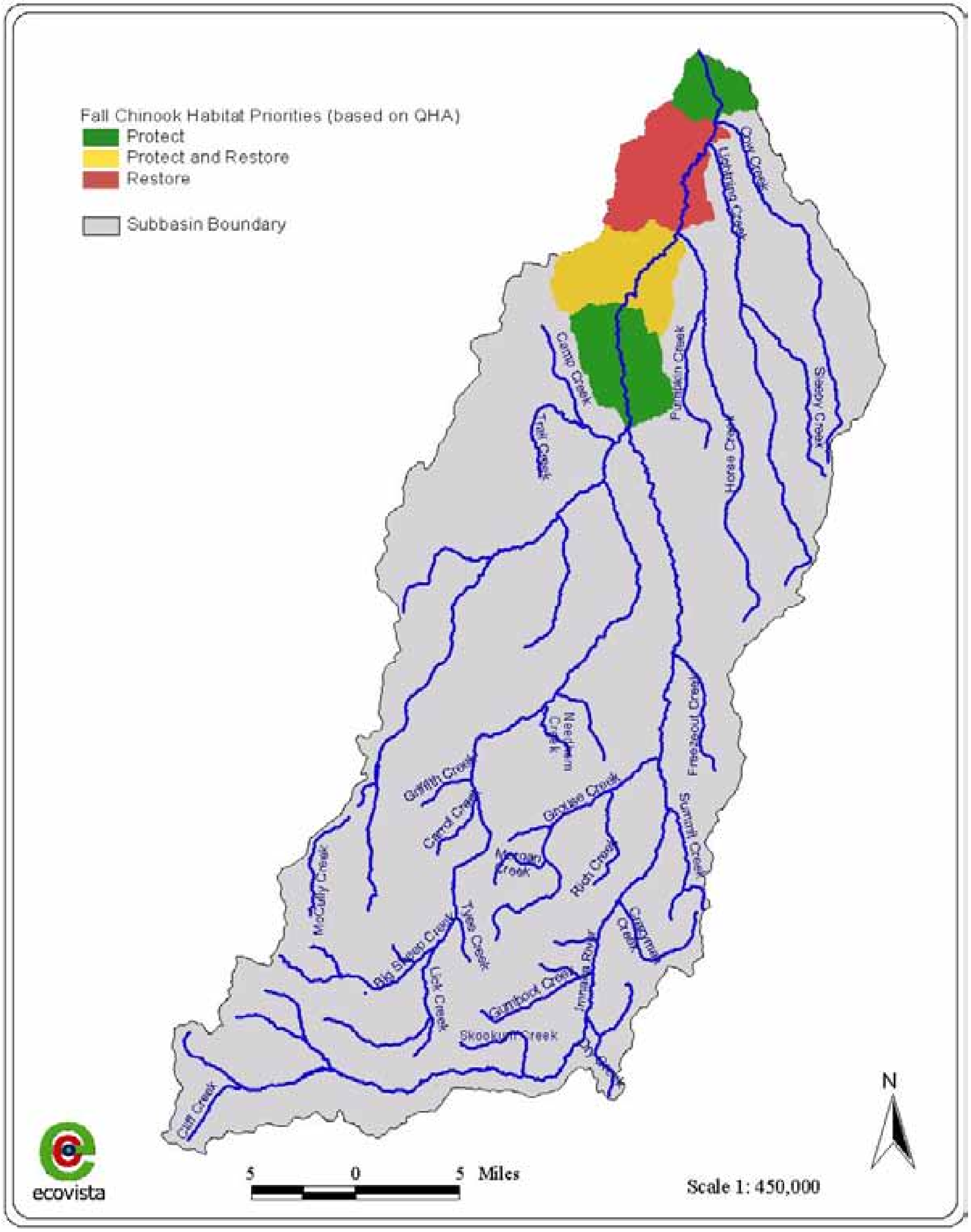

Figure 69. QHA-based restoration and protection areas for fall chinook in the Imnaha subbasin

Table 97. Comparative restoration versus protection value for summer steelhead sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity.

Protection Rank / Restoration Rank[1]	High	Moderate	Low
High (Note: Cells in this row have streams listed in order of Restoration Rank)	**Priority = <u>Restore</u>**	**<u>Priority = Restore</u>** 07K Big Sheep Creek 1 07M Big Sheep Creek 2 07P Big Sheep Creek 3 09F Grouse Creek Upper 07E Summit Creek (Bear&DowneyGulch) 07D Little Sheep Creek 1 07O Carrol Creek 09K Gumboot Creek 09D Grouse Creek Confluence	**<u>Priority = Restore</u>** 07H Little Sheep Creek 2 09A Imnaha River 4 08D Imnaha River 3 (Town) 08B Imnaha River 1 07J Little Sheep Creek 3 (Redmont, Ferg., Canal) 07B Lower Camp Creek
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	**Priority = <u>Protect</u>** 08L Cow Creek - Upper 08F Pumpkin Creek 08G Horse Creek Upper 08J Lightning Creek - Upper 08K Cow Creek Confluence 08H Lightning Creek Confluence 09J Imnaha River 7	**Priority =** **<u>Protect & Restore</u>** 09G Imnaha River 6 09H Summit Creek 07Q Lick Creek 07N Marr Creek 08E Horse Creek Confluence 09E Rich Creek/Shadow Canyon 07G Lightning Creek	**<u>Priority = Restore</u>** 08C Imnaha River 2 07C Upper Camp Creek
Low (Note: Cells in this row have streams listed in order of Protection Rank)	**<u>Priority = Protect</u>** 09L Imnaha River 8 09M Imnaha River 9 09N Imnaha River 09B Freezeout Creek 09I Crazyman Creek 09C Imnaha River 5 07F Devils Gulch 07L Squaw Creek	**<u>Priority = Protect</u>**	**<u>Priority = Protect</u>** 08A Imnaha River Confluence 08I Sleepy Creek 07I McCully Creek 07R Big/Little Sheep Headwaters 07A Big Sheep Creek Mouth 09O North Fork Imnaha River 09P South Fork Imnaha River

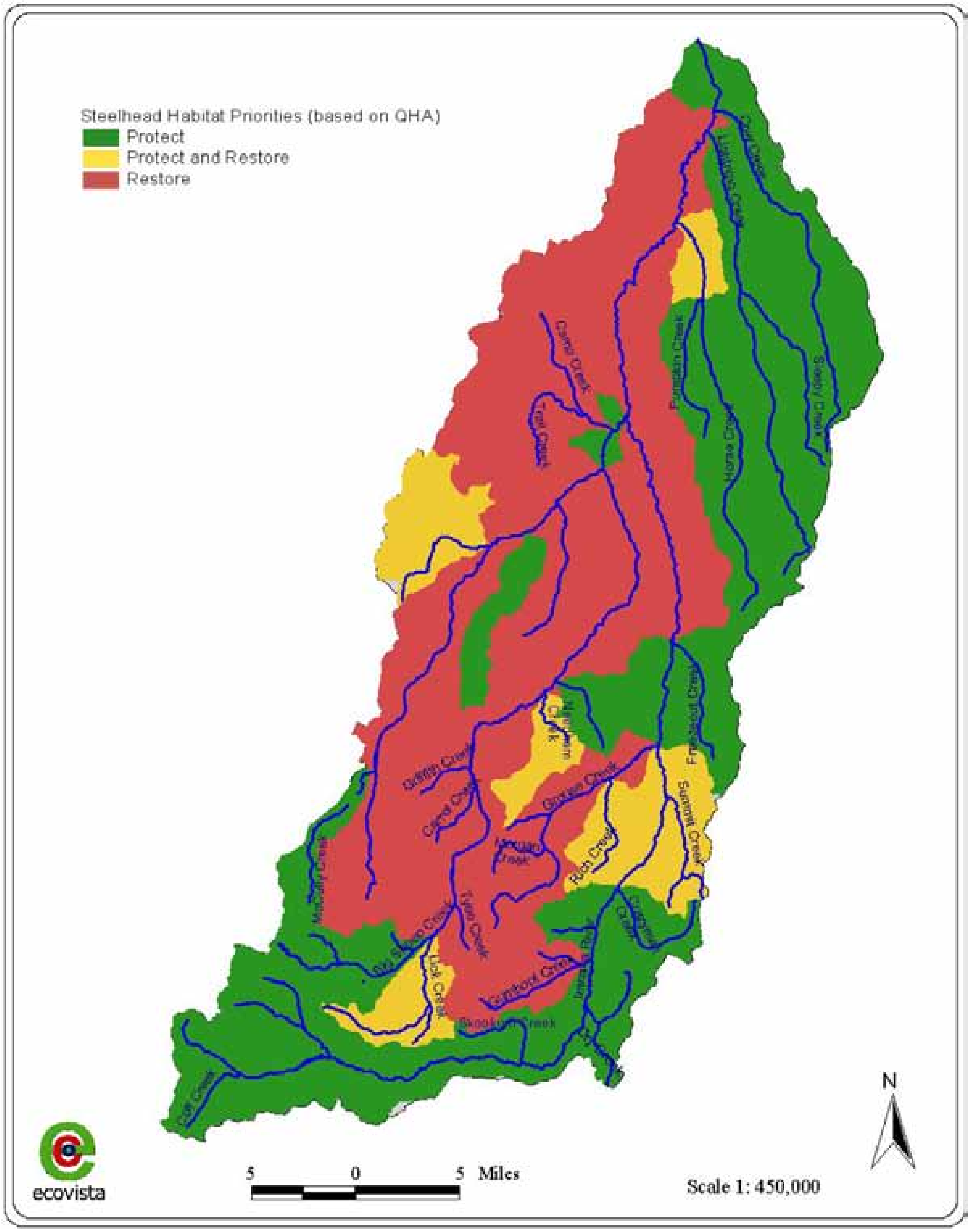

Figure 70. QHA-based restoration and protection areas for summer steelhead in the Imnaha subbasin

Table 98. Restoration ranks[1] for sixth code HUCs and habitat variables within each, for HUCs occupied by summer steelhead within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name[2]	Length (Miles)[3]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	07H Little Sheep Creek 2	13.5			2			3			1		
2	09A Imnaha River 4	12.7			2			3			1		
3	07K Big Sheep Creek 1	12.9		3	3			2			1		
4	07M Big Sheep Creek 2	10.9	3					2			1		
5	07P Big Sheep Creek 3	13.1				3		2			1		
6	09F Grouse Creek Upper	13.2	3	1		2							
7	07E Summit Creek (Bear&DowneyGulch)	6.0	3			2					1		
7	08D Imnaha River 3 (Town)	8.7			2			3			1		
9	07D Little Sheep Creek 1	8.2			2			3			1		
9	08B Imnaha River 1	7.2			3	2					1		
11	07O Carrol Creek	11.1				1		3			2		
11	09K Gumboot Creek	11.7				3		2			1		
13	09D Grouse Creek Confluence	9.3	2				3				1		
14	07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	6.2				1		3					2
15	07B Lower Camp Creek	6.1		2		3					1		
16	08L Cow Creek Upper	9.7		1							3	2	
17	08F Pumpkin Creek	12.0				2					1	3	
17	09G Imnaha River 6*	13.3			3	2					1		
17	09H Summit Creek*	7.7		3	3			2			1		
20	08G Horse Creek Upper	8.2				1					3	2	
20	08J Lightning Creek Upper	5.3				1					3	2	
20	08K Cow Creek Confluence	11.0			2		3				1		
23	07Q Lick Creek*	8.3	3	2				1					
23	08C Imnaha River 2	6.1			3	2					1		
25	07N Marr Creek*	12.0					3	2			1		
26	07C Upper Camp Creek	10.3			2	3					1		
26	08E Horse Creek Confluence*	3.8				3		2			1		
26	08H Lightning Creek Confluence	3.6			1		2					3	
26	09E Rich Creek/Shadow Canyon*	6.3	2				3				1		
30	07G Lightning Creek*	5.7		2	2						1		
30	09J Imnaha River 7	5.5			2		3				1		
32	09C Imnaha River 5	2.5			2		3				1		
32	09M Imnaha River 9	3.2		3	3			2			1		
34	07A Big Sheep Creek Mouth*	7.3			2			3			1		
35	07F Devils Gulch	4.4				1	3					2	
36	07R Big/Little Sheep Headwaters*	2.8				2	3	1					
37	07L Squaw Creek	3.8					3	2			1		
37	08A Imnaha River Confluence*	4.4			2			3			1		
37	09B Freezeout Creek	8.3					2				1	3	

Restoration Rank	Reach Name[2]	Length (Miles)[3]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
37	09I Crazyman Creek	4.1					2				1	3	
41	09L Imnaha River 8	5.8		3	3			2			1		
41	09N Imnaha River	5.4		3	3			2			1		
43	07I McCully Creek*	4.1					2	1					3
44	08I Sleepy Creek*	6.0						3			2	1	
45	09O North Fork Imnaha River*	5.8					2	3			1		
45	09P South Fork Imnaha River*	2.1		2							3		1

[1]/ Uses 'adjusted' reach ranks (previously described) to give weight to amount of usable habitat (stream length)
[2]/ HUCs prioritized as "Protect and Restore" in Table 97 are included in both Table 98 and Table 99 and are marked with and asterisk (*)
[3]/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which steelhead use for either spawning/incubation, summer/winter rearing, or migration (ODFW data)

Table 99. Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by summer steelhead within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Protection Rank	Reach Name[1]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	09L Imnaha River 8						3			2	1	
1	09M Imnaha River 9						3			2	1	
1	09N Imnaha River						3			2	1	
4	08G Horse Creek Upper						3			2	1	
4	08J Lightning Creek Upper						3			2	1	
6	08L Cow Creek Upper						3			2	1	
7	08H Lightning Creek Confluence						3			2	1	
8	09B Freezeout Creek		3	3			2				1	
8	09I Crazyman Creek		3	3			2				1	
10	08F Pumpkin Creek		3	3			2				1	
11	08K Cow Creek Confluence		3				2				1	
11	09J Imnaha River 7		3				2				1	
13	09C Imnaha River 5		3				2				1	
14	07F Devils Gulch						2			3	1	
15	07L Squaw Creek		2	2							1	
15	07N Marr Creek*		2	2							1	
17	09E Rich Creek/Shadow Canyon*		2	2							1	
18	09G Imnaha River 6*		3				2				1	
19	09D Grouse Creek Confluence		2	2							1	
20	07E Summit Creek (Bear&DowneyGulch)		3				2				1	
21	09F Grouse Creek Upper			3						2	1	
22	07M Big Sheep Creek 2		2		3						1	
23	08E Horse Creek Confluence*	3	2								1	
24	09K Gumboot Creek		2	2							1	
25	07P Big Sheep Creek 3		2	2							1	
26	07Q Lick Creek*			3						2	1	
27	09H Summit Creek*									3	1	2
28	07K Big Sheep Creek 1				2						1	3
29	07O Carrol Creek			2						3	1	
30	07G Lightning Creek*						2			3	1	
31	07D Little Sheep Creek 1						3				1	2
31	09A Imnaha River 4						3				1	2
33	08A Imnaha River Confluence*	3					2				1	3
34	07H Little Sheep Creek 2		3				2				1	
35	08I Sleepy Creek*						3			2	1	
36	08C Imnaha River 2						2				1	3
37	08B Imnaha River 1		3				2				1	
38	07I McCully Creek*		3	3						2	1	
39	07R Big/Little Sheep Headwaters*			3						2	1	
40	07A Big Sheep Creek Mouth*						3				1	2

Protection Rank	Reach Name[1]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
41	07B Lower Camp Creek						3			2	1	
42	08D Imnaha River 3 (Town)						3				1	2
43	07C Upper Camp Creek		3				2				1	
44	07J Little Sheep Creek 3 (Redmont, Ferg., Canal)			3						2	1	
45	09O North Fork Imnaha River*					3				2	1	
46	09P South Fork Imnaha River*		2							2	1	

[1]/ HUCs prioritized as "Protect and Restore" in Table 97 are included in both Table 98 and Table 99 and are marked with and asterisk (*)

Table 100. Comparative restoration versus protection value for bull trout sixth field HUCs within the Imnaha subbasin based on (modified) QHA ranks for each activity

Protection Rank / Restoration Rank[1]	High	Moderate	Low
High (Note: Cells in this row have streams listed in order of Restoration Rank)	**Priority = <u>Restore</u>** 07R Big Sheep Creek 4 (headwaters) 09M Imnaha River 9	**<u>Priority = Restore</u>**	**<u>Priority = Restore</u>** 07H Little Sheep Creek
Moderate (Note: Cells in this row have streams listed in order of Restoration Rank)	**Priority = <u>Protect</u>** 07J Little Sheep Creek Headwaters 07I McCully Creek 07P Big Sheep Creek 3 07Q Lick Creek 09J Imnaha River 7	**Priority = <u>Protect & Restore</u>** 09G Imnaha River 6 09A Imnaha River 4	**<u>Priority = Restore</u>** 07K Big Sheep Creek 1 08B Imnaha River 1 07D Little Sheep Creek 1 07M Big Sheep Creek 2 08C Imnaha River 2
Low (Note: Cells in this row have streams listed in order of Protection Rank)	**<u>Priority = Protect</u>** 09N Imnaha River 09P South Fork Imnaha River 09O North Fork Imnaha River 09L Imnaha River 8	**<u>Priority = Protect</u>** 09C Imnaha River 5 08A Imnaha River Confluence	**<u>Priority = Protect</u>** 08D Imnaha River 3 07A Big Sheep Creek

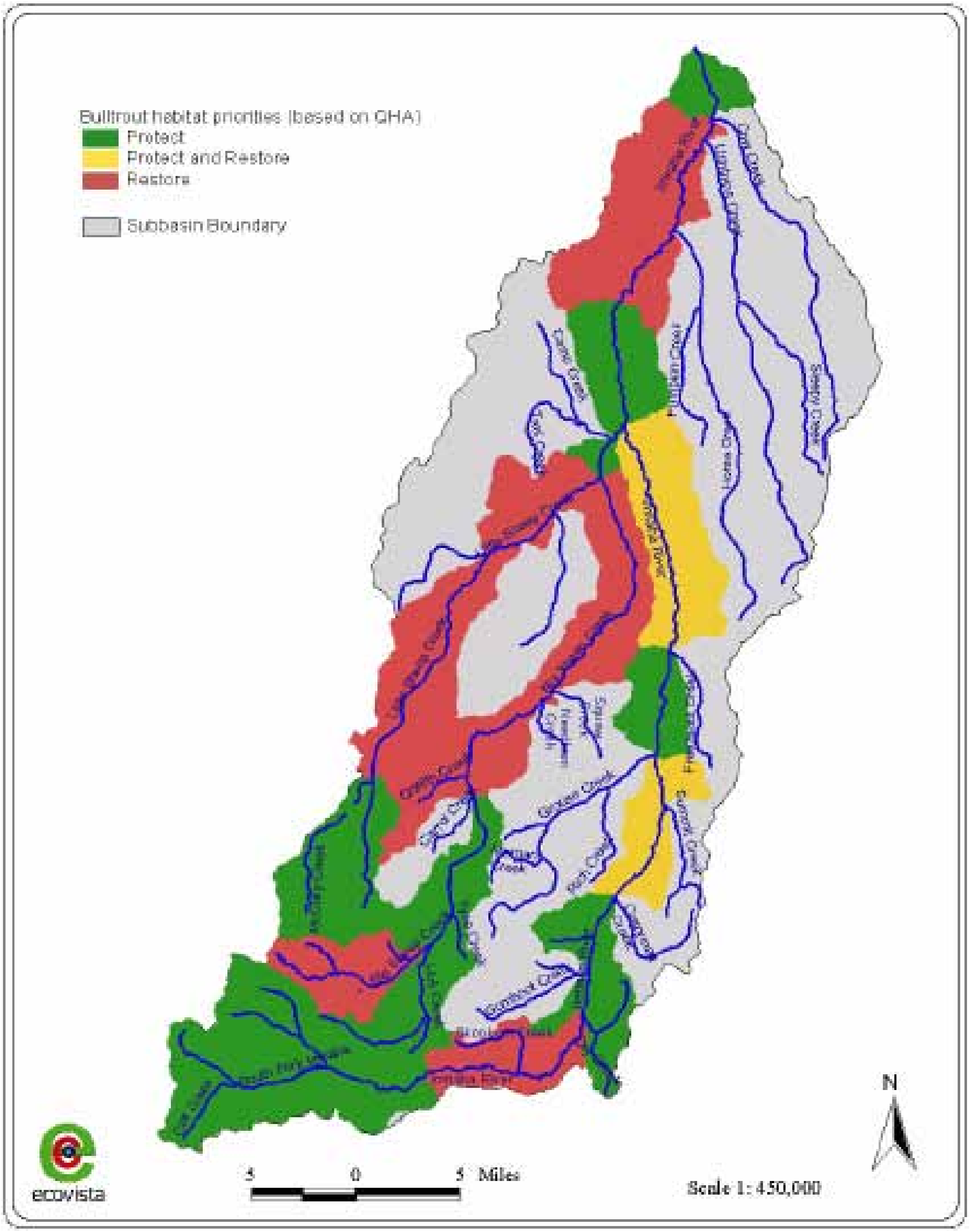

Figure 71. QHA-based restoration and protection areas for bull trout in the Imnaha subbasin

Table 101. Restoration ranks[1] for sixth code HUCs and habitat variables within each, for HUCs occupied by bull trout within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows.

Restoration Rank	Reach Name[2]	Length (Miles)[3]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	07R Big Sheep Creek 4 (headwaters)*	12.60	2					3					1
2	07J Little Sheep Creek Headwaters	15.42				4		2			2		1
3	07I McCully Creek	10.14				3						2	1
4	07P Big Sheep Creek 3	8.50	2	3							1		
5	07Q Lick Creek	9.41	1				2	3					3
6	07H Little Sheep Creek	13.35						2			2	1	4
7	09M Imnaha River 9*	10.45		3	5	3	5	1			1		5
7	07K Big Sheep Creek 1	12.92	4					2			1	2	
7	09G Imnaha River 6*	8.21			3	2					1		
10	09J Imnaha River 7	3.95				1					2		3
11	07D Little Sheep Creek 1	7.17	4					2			1	2	
11	08B Imnaha River 1	7.22						2			1		
11	09A Imnaha River 4*	12.65			2						1		
14	07M Big Sheep Creek 2	8.15	3								2	1	
14	08C Imnaha River 2	5.43						2			1		
14	08D Imnaha River 3*	6.52						2			1		
17	07A Big Sheep Creek*	3.19						2			1	2	
17	08A Imnaha River Confluence*	3.79				2	2	2			1	2	2
17	09C Imnaha River 5	5.77				2					1	2	2
17	09L Imnaha River 8	2.36						2			1		
17	09P South Fork Imnaha River	10.63				1							
22	09N Imnaha River	5.71				1							
22	09O North Fork Imnaha River	6.80				1							

[1]/ Uses 'adjusted' reach ranks (previously described) to give weight to amount of usable habitat (stream length)
[2]/ HUCs prioritized as "Protect and Restore" in Table 100 are included in both Table 101 and Table 102 and are marked with and asterisk (*)
[3]/ Measurement is an estimate of the total length of stream channels within a sixth field HUC for which bull trout use for either spawning/incubation, summer/winter rearing, or migration (ODFW data)

Table 102. Protection ranks for sixth code HUCs and habitat variables within each, for HUCs occupied by bull trout within the Imnaha subbasin. HUC ranks are comparable between rows; variable ranks are comparable only within rows

Protection Rank	Reach Name[1]	Riparian Condition	Channel Form	Channel Stability	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	09N Imnaha River		4				1			1	1	
1	09P South Fork Imnaha River		4				1			1	1	
3	09O North Fork Imnaha River	4		4		4	1			1	1	4
4	09M Imnaha River 9*						2			2	1	
5	07R Big Sheep Creek 4 (headwaters)*						3			2	1	
6	09L Imnaha River 8				3		2				1	
7	09J Imnaha River 7		3				1				1	
8	07Q Lick Creek		1		1		5			1	1	
9	07I McCully Creek		3				2			1		
10	07P Big Sheep Creek 3			3	3		2				1	
11	07J Little Sheep Creek Headwaters		2				3			3		
12	09G Imnaha River 6*		4			4	1				1	3
13	09C Imnaha River 5	4	4			4	1				1	1
14	09A Imnaha River 4*	4	4			4	1				1	1
15	08A Imnaha River Confluence*	4	4				1				1	1
16	07M Big Sheep Creek 2						1			3	3	1
17	08C Imnaha River 2						3				1	1
18	08D Imnaha River 3*						3				1	1
19	08B Imnaha River 1						3				1	1
20	07K Big Sheep Creek 1						2				2	1
21	07D Little Sheep Creek 1						2				2	1
22	07A Big Sheep Creek*						2				2	1
23	07H Little Sheep Creek						2				3	1

[1]/ HUCs prioritized as “Protect and Restore” in Table 100 are included in both Table 101 and Table 102 and are marked with and asterisk (*)

1.5.2 Local Factors Limiting Terrestrial Species

The primary limiting factors for wildlife in the Imnaha subbasin were selected based on a comparison of threats identified for focal and concern species, with changes in habitat conditions identified at the scale of the WHT, structural condition and KEC (see section.) or KEF (see section 1.4). Seven factors emerged as being the most limiting to the terrestrial communities and their dependent wildlife species in the subbasin. Not surprisingly, these factors are similar to those identified in the broader-scale assessments conducted during the Interior Columbia Ecosystem Management Project (Quigley and Arbelbide 1997, Wisdom 2000). The local limiting factors identify the habitat features in the subbasin that appear to have been most altered between historical and current times.

Addressing these habit level limiting factors will provide the greatest benefit to the greatest number of species and the limiting factors were used as the starting point for the development of the objectives and strategies section of the Imnaha Subbasin Management Plan. There is a level of overlap between the limiting factors that is inherent to both this ecosystem level approach and the way the limiting factor were selected, for example, it was determined in section 1.2.10 that the loss and degradation of the grassland habitats in the subbasin was a primary limiting factor to the wildlife species that depend on these habitats. At the finer scale of the KEC it was determined that noxious weeds and invasive plant species were also primary limiting factor to the wildlife species of the subbasin. The impacts of noxious weed and invasive plant infestation have been most profound in the grassland habitats of the Imnaha subbasin and have been among the primary mechanism for their degradation. The selection of both of these factors as limiting factors will result in some duplication in the development of objectives and strategies in the Management Plan but also provided an opportunity for the technical team to look at the issue from different perspectives and at different scales resulting in a more comprehensive plan for addressing these problems.

Loss of Ponderosa Pine Communities

Data from the Northwest Habitat Institute indicate that the distribution of the Ponderosa Pine WHT has declined by 47% in the Imnaha subbasin between historical and current. Similar results have been documented by Quigley and Arbelbide (1997) and Wisdom (2000) at the scale of the Columbia Basin. Fire suppression and selective timber harvest are the practices most responsible for losses of ponderosa pine habitat both at the scale of the Imnaha subbasin and the Columbia Basin. Fire suppression has allowed more shade tolerant species to establish and overtop ponderosa pine in many areas of the subbasin. Selective timber harvest has targeted commercially valuable large ponderosa pines, reducing both the extent of the WHT and the amount of large structure ponderosa pines, which are particularly valuable to wildlife.

Reductions in the abundance of mature ponderosa pine have likely impacted populations of ponderosa pine dependent wildlife species in the subbasin. Ponderosa pine habitats are important to a variety of wildlife in a variety of ways. Bald eagles are often observed perched in mature ponderosa pine trees (Cassirer 1995). White-headed woodpeckers are completely dependant on the seeds of the Ponderosa pine for winter feeding and show a preference for these habitat types for nesting and foraging during other seasons of the year. Flammulated owl habitat includes open stands of fire-climax ponderosa pine or Douglas-fir forests (See Section 1.2.9.1 for details). Twenty-one of the subbasin's wildlife species (12 birds and 9 mammals) are closely associated with ponderosa pine habitat types (see section 1.2.10.1 and Appendix A for details. Five of the species closely associated with ponderosa pine habitats in the subbasin are concern or focal species (Table 103).

Table 103. Concern and focal species of the Imnaha subbasin closely associated with ponderosa pine habitats (Johnson and O'Neil 2001).

Common Name	Scientific Name
Flammulated owl	*Otus flammeolus*
Great gray owl	*Strix nebulosa*
Northern goshawk	*Accipiter gentilis*
Pygmy nuthatch	*Sitta pygmaea*
White-headed woodpecker	*Picoides albolarvatus*

Protecting areas of existing mature ponderosa pine and facilitating the development of additional areas of ponderosa pine habitat is an important issue for the ponderosa pine dependent wildlife in the subbasin. Strategies for maintaining existing and developing additional mature ponderosa pine habitat were developed by the terrestrial subcommittee of the Imnaha subbasin technical team and are outlined in the *Imnaha Subbasin Management Plan* (Objective15). Table 104 shows the current distribution of all ponderosa pines and large and giant size ponderosa pines by subwatershed. Areas containing significant amounts of large ponderosa pines should be considered for protection, while areas with ponderosa pines not in mature size classes should be considered for silvicultural treatments that will preserve the ponderosa pine component and help move it into late seral stages. The data represented in Table 104 is relatively coarse scale continuing inventory will need to be a component of efforts to protect and restore ponderosa pine habitats in the subbasin.

Table 104. Distribution of the ponderosa pine WHT in the Imnaha subbasin by subwatershed.

Subwatershed[1]	Current Ponderosa Pine WHT (acres) (Based on NHI Current WHT Distributions)	Percentage (%) of Watershed Ponderosa Pine	Large or Giant (>21 inches dbf) Ponderosa Pine (acres) (Based on ONHP Size Class Data)	Percentage (%) of Ponderosa Pine WHT Large or Giant Size Class
07A	80.8	2.8	25.2	31.2
07B	1343.9	10.2	0.7	0.0
07C	571.1	3.0	0.0	0.0
07D	1099.0	8.9	201.4	18.3
07E	1087.2	7.3	244.2	22.5
07F	321.4	4.1	12.0	3.7
07G	32.7	0.2	0.0	0.0
07H	545.9	2.2	0.0	0.0
07I	419.4	5.8	0.0	0.0
07J	60.1	0.5	0.0	0.0
07K	1110.0	5.9	214.8	19.4

Subwatershed[1]	Current Ponderosa Pine WHT (acres) (Based on NHI Current WHT Distributions)	Percentage (%) of Watershed Ponderosa Pine	Large or Giant (>21 inches dbf) Ponderosa Pine (acres) (Based on ONHP Size Class Data)	Percentage (%) of Ponderosa Pine WHT Large or Giant Size Class
07L	117.3	1.9	45.9	39.1
07M	377.9	2.6	168.2	44.5
07N	228.8	3.4	148.8	65.0
07O	154.5	2.2	41.7	27.0
07P	237.3	1.7	57.9	24.4
08A	230.5	4.1	0.0	0.0
08B	2100.6	13.8	28.5	1.4
08C	1081.0	7.8	0.2	0.0
08D	839.2	6.6	0.0	0.0
08E	728.7	13.1	0.0	0.0
08F	602.2	8.4	81.8	13.6
08G	2235.1	10.2	15.2	0.7
08H	1614.3	14.8	0.0	0.0
08I	958.7	8.2	0.0	0.0
08J	1027.0	6.2	0.0	0.0
08K	1516.8	12.7	0.0	0.0
08L	354.4	2.6	0.0	0.0
09A	1166.8	5.1	15.8	1.4
09B	230.7	2.3	0.0	0.0
09C	972.5	10.8	5.3	0.5
09D	197.5	1.9	11.8	6.0
09E	31.4	0.6	10.9	34.7
09G	739.1	6.2	0.0	0.0
09H	215.6	3.4	0.0	0.0
09I	5.3	0.1	0.0	0.0
09J	99.9	1.6	0.0	0.0
09K	7.3	0.1	0.0	0.0
09L	67.0	0.8	16.5	24.6
09M	287.2	2.3	148.4	51.7

[1] Subwatersheds 07Q, O7R, 09F, 09N, 090, and 09P contain no ponderosa pine WHT.

Degradation of Grassland Habitats

Grassland ecosystems have suffered the greatest losses of any habitats in the Columbia Plateau (Kagan et al.1999). The fescue-bunchgrass cover type, which dominates the subbasins grasslands has declined by two thirds from historic levels across the Columbia Basin (Quigley and Arbelbide 1997). Relative to many other parts of the Columbia Basin, the grassland habitats of the Imnaha subbasin are in good condition. Most are in mid-late seral stages and dominated by native vegetation; however, there are areas where historical overgrazing has damaged the subbasin's grasslands and allowed annual grasses and noxious weeds to establish.

Native grasslands of the region evolved without the heavy grazing pressures that occurred on the Great Plains (Mancuso and Moseley 1994). Heavy grazing in the late 1800s and early 1900s led to alterations in the community structure and aided in colonization by exotic annual grasses and noxious weeds (USFS 1999). Biological soil crusts are an important component of grassland habitats. Crusts reduce wind and water erosion by increasing soil stability, retaining moisture, and increase soil fertility through the addition of carbon, organic matter and soil micronutrients. Biological soil crusts develop slowly and are fragile in some areas crusts in the subbasin have been damaged through grazing, off-road vehicle use, invasion by exotic annual grasses, and fire (USFS 2003a).

Natural succession processes and changes in management have resulted recent upward trends in the condition of grassland habitats in much of the subbasin (USFS 2003a). However, some areas are still degraded. The lower canyon benches dominated by sand dropseed and/or red threeawn tend to exhibit the worst condition of any grassland community in the subbasin (USFS 1995, 1998). Reduced grassland habitat quality has reducing the subbasins ability to support grassland dependent wildlife species.

The most recent analysis of grassland condition in the subbasin has been conducted by the Forest Service for HCRNA grasslands in support of their HCRNA CMP (USFS 2003a). The Forest Service evaluates grassland seral stages to assess the current departure of a specific site from the Potential Natural Condition (PNC) for that site. A seral stage determination is an evaluation of the successional status of the plant community occurring on a site compared with the PNC that would occur on that site if succession progressed absent of outside influences. PNC is based on an evaluation of site characteristics including geology, soils, aspect, climate, elevation, etc., compared to similar site characteristics from areas evaluated and estimated by plant ecologists to be at or near their biotic potential. The types of vegetation associated with each seral class are described below; historically the grasslands in the HCNRA were dominated by mid to late seral-stage vegetation (USFS 2003a).

- Late- the natural/native species community perennial bunchgrasses dominate, with bare ground subordinate to other surface features (rock, gravel, microbiotic crusts, litter).
- Mid – native perennial forbs and grasses co-dominate with the potential natural community perennial bunchgrasses. Bare ground is subordinate or equivalent to other surface features.
- Early – native perennial forbs and other native grasses dominate over the potential natural community perennial bunchgrasses. Bare ground is equivalent to or more extensive than other surface features.
- Very early (Disclimax) – potential natural community perennial bunchgrasses are present on less than 5 percent of the stand. Bare ground is more extensive than other surface features.

Current information about the condition of HCNRA grasslands is limited and based on current and historic inventories (USFS 2003a). The USFS recently compared the existing grassland inventory information to the PNV to determine the ecological condition of grasslands on the HCNRA. Generally, satisfactory condition rangeland is in a mid-seral stage or later with a stable or improving condition trend. Two techniques were used to assess the condition of grasslands in the HCRNA. The first technique evaluated the ecological status and condition of permanent monitoring points on suitable or capable grazing lands. This technique identified that 76 percent of the sites were in satisfactory condition. The second technique analyzed ecological condition inventories on eight allotments, which included one vacant allotment selected to represent the diversity of conditions throughout the HCNRA. Analysis of capable and suitable acres on these allotments indicates 97 percent of the grazing allotments on the HCNRA are in satisfactory condition. Both analysis excluded areas such as historic homesteads, benches (plowed and farmed), and some of the flatter bottomlands and ridges where livestock were historically concentrated and where site potentials have been permanently altered; these areas contain the majority of early and very-early seral grasslands in the HCRNA (USFS 2003a). Alternative E-modified the selected alternative in the HCNRA CMP focuses grassland restoration efforts in the HCRNA on deep soil benches in early seral condition.

The loss and degradation of grassland habitats in the subbasin has the potential to impact the numerous wildlife species that depend on these habitats. Species that are closely associated with the eastside grassland WHT would be expected to be the most impacted but the numerous other species that use grassland habitats could also be affected. Strategies for the improvement of grassland habitat condition and protection of existing high quality grassland areas were developed by the terrestrial subcommittee of the Imnaha subbasin technical team (Objectives 14A and 14B management plan).

Degradation of Riparian Habitats

Riparian habitats are immensely valuable to both fish and wildlife populations in the subbasin. More of the subbasins wildlife species are more closely associated with wetland and riparian WHTs than with any other WHT (Appendix A). Eighty-one species in the subbasin are closely associated with herbaceous wetlands, while 14 are closely associated with coniferous wetlands. Many other species use riparian and wetland habitat occasionally or as travel corridors. Riparian habitats in the Imnaha subbasin have been altered through various human activities, including livestock grazing, timber harvest, and road construction. Alterations in vegetative structure and disturbance regimes have contributed to increased intensity fire, flood and insects outbreaks, which have also reduced riparian quality. The Imnaha subbasin Multi-species Biological Assessment identified 17 subwatershed in the subbasin where riparian conditions are functioning at risk (7A,7D,7E,7H,7J,7K,7M,7O,7P,7Q, 8D, 9A,9D,9E,9F,9H,9K; see Figure 3 for locations). Riparian areas in the remaining twenty-nine subwatersheds are thought to be functioning appropriately.

Subwatersheds with riparian areas that are functioning at risk are concentrated in the Big and Little Sheep Drainages. In lower portions of this drainage riparian species, such as cottonwood and ponderosa pine, by grazing, cultivation, homesteading/clearing, and road construction (USFS 2000). In the upper watershed, insect infestations and the Canal Creek Fire of 1989 have reduced effective stream shade-providing riparian vegetation. Engelmann spruce is sparse in the Big Sheep Creek riparian zones, as they have suffered 50 to 100% mortality due to insect infestations. Consequently, much of the overstory in the primary riparian zone is missing or dead and where Engelmann spruce mortality has been high, a grass/forb community dominates the primary riparian zone (USFS 2001).

Conditions in the riparian zones of much of the subbasin have shown improvements due to protection and restoration resulting from the 1992 listing of salmon as a threatened species (USFS 1999). Strategies for further improvement of the condition of riparian and wetland habitats in the subbasin and the preservation of high-quality areas were developed by the technical team in objective 16A and 16B of the *Imnaha Subbasin Management Plan*. Strategies developed to improve the next limiting factor 'changes in disturbance regime and vegetative structure' will help to protect riparian areas from catastrophic fires.

Changes in disturbance regime and vegetative structure

Fire suppression has resulted in increased accumulation of fuels, higher tree densities, and the accumulation of duff. These conditions create a situation in which even light severity fires can be damaging due to the concentrated heating of the tree bole. The accumulation of ground fuels along with denser, multi storied stand conditions have created "fuel ladders" that cart fire into the tree canopy, resulting in high intensity crown fires. Unlike the moderate severity fires that burned historically, many wildfires now have the potential to impact soil productivity and increase erosion through the consumption of organic matter and high temperature that may result. The net result is wildfires that are more severe and more difficult to control (BLM 2002). Over the past 100-plus years, the percentage of higher burn intensities in Blue Mountain forests has increased beyond historic conditions (Johnson 1998). Focal species threatened by large stand-replacing fires include the boreal owl, olive-sided flycatcher and American marten (USFS 2003b).

Fire suppression has resulted in a shift to more shade tolerant tree species and contributed to the development of dense, multi-layered stands. Forests with these conditions are more susceptible to insects and disease than forests developed in more natural disturbance regimes (USFS 1998).

These changes in forest vegetative conditions are illustrated by the increase of fuel model 9 or 10 in the subbasin (See section 1.1.3.2 and 1.1.3.3 for details). Fires burning in fuel models 9 and 10 can have much higher intensities, are more difficult to suppress, and have longer and more severe ecological impacts than other fires. Large fires result in a more homogenous distribution of structural conditions and can reduce the diversity of species an area can support. Returning to a more natural fire regime through prescribed burning would reduce the threat of large-stand replacement fires and promote large diameter trees and snags. Table 105 shows the percentage of the fuel model data in the subwatershed that is fuel model data 9 or 10. Subwatersheds comprised of large areas of fuel model 9 and 10, may need to be considered for vegetative treatment and prescribed burning to reduce fuel loads and protect habitat for wildlife and fish. Because some forests naturally exhibit fuel model 9 and 10 characteristics, making these decisions will require on the ground surveys to determine where conditions pose the greatest risk of catastrophic fire. During technical team meetings tow areas of great concern were identified the Lick Creek (O7Q) and Gumboot (09K) subwatersheds.

Altered disturbance regimes have changed the abundance and distribution of forest structural conditions in the subbasin from what was historically present (see sections 1.1.3.3 and 1.2.10 for details). Many areas of the subbasin are under represented for mature forest habitat types when compared with the historical range of variability (See section 1.2.10 for details). Mature forests and the key environmental correlate (snags, downed wood etc.) they usually contain are very important to numerous wildlife species, including the American marten, boreal owl, and olive-sided flycatcher focal species. Deficits in the late and old structural stages in the subbasin are most pronounced where timber harvest, uncharacteristic fire and insect infestations have occurred (USFS 2003). As shown in section 1.2.10 , large-single storied stands comprised more than 20 % of the area with data in only one HUC 07N. Large multi-storied stands are better distributed and comprise more than 20% of the area with data in HUCs 07A, 07E, 07K, 07M, 07O, 08F, 09M. Strategies for restoring more natural disturbance regimes and forest structural conditions to the subbasin and protecting existing large structural condition forests were developed by the technical team in objective 18A of the *Imnaha Subbasin Management Plan.*

Table 105. Subwatersheds with a high concentration of fuel models 9 and 10.

Subwatershed[1]	**Percentage (%) of subwatershed with fuel model data in fuel model 9 or 10**
07A	0.0
07E	0.0
07I	36.7
07J	35.1
07K	4.7
07L	31.4
07N	34.8
07O	37.6
07P	35.6
07Q	**47.7**
07R	27.4
08A	0.0
08B	0.9
08C	0.0
08E	0.0
08F	22.1
08G	35.0
08H	6.3
08I	33.7
08J	24.7
08K	10.9
08L	31.7
09A	9.5
09B	33.4
09C	73.9
09D	51.4
09E	51.5
09F	57.0
09G	35.5
09H	31.8
09I	18.8
09J	19.3
09K	**28.8**
09L	12.8
09M	40.6

Subwatershed[1]	Percentage (%) of subwatershed with fuel model data in fuel model 9 or 10
09N	27.3
09O	39.2
09P	52.3

[1]Subwatersheds with fuel model data for less than 50% of the subwatershed were removed from the analysis (07B, 07C, 07D, 07F, 07G, 07H, 07M).

Roads and Habitat Fragmentation

Even though road densities in the subbasin are relatively low, the transportation system of the Imnaha subbasin is a limiting factor to wildlife populations in some areas of the subbasin.

More than 65 species of terrestrial vertebrates in the interior Columbia River basin have been identified as being negatively affected by road-associated factors (Wisdom et al. 2000). Road-associated factors can negatively affect habitats and populations of terrestrial vertebrates both directly and indirectly. Wisdom et al. (2000) identified 13 factors consistently associated with roads in a manner deleterious to terrestrial vertebrates (Table 106). The Wallowa-Whitman National Forest uses the following classes to quantify in general terms the impact of roads on wildlife sensitive to open roads: low impacts can be expected in areas with a density less than 1.0 mi./sq. mi, a moderate impact at densities between 1.0-2.5 mi./sq. mi., and a high impact when densities are greater than 2.5 mi./sq. mi. of open road (USFS 2003a). The Imnaha Subbasin Multi-Species BA considered both the density and location of roads when considering the potential impacts of roads on listed aquatic species. These ratings may also be useful for getting a general idea of the potential impacts of roads on terrestrial, particularly riparian dependent, species and are displayed in Table 106.

Table 106. Road-associated factors with deleterious impacts on wildlife (Wisdom et al. 2000).

Road-Associated Factor	Effect of Factor in Relation to Roads
Snag reduction	Reduction in density of snags due to their removal near roads, as facilitated by road access
Down log reduction	Reduction in density of large logs due to their removal near roads, as facilitated by road access
Habitat loss and fragmentation	Loss and resulting fragmentation of habitat due to establishment and maintenance of road and road right-of-way
Negative edge effects	Specific case of fragmentation for species that respond negatively to openings or linear edges created by roads
Overhunting	Nonsustainable or nondesired legal harvest by hunting as facilitated by road access
Overtrapping	Nonsustainable or nondesired legal harvest by trapping as facilitated by road access
Poaching	Increased illegal take (shooting or trapping) of animals as facilitated by road access

Collection	Collection of live animals for human uses (e.g., amphibians and reptiles collected for use as pets) as facilitated by the physical characteristics of roads or by road access
Harassment or disturbance at specific use sites	Direct interference of life functions at specific use sites due to human or motorized activities, as facilitated by road access (e.g., increased disturbance of nest sites, breeding leks or communal roost sites)
Collisions	Death or injury resulting from a motorized vehicle running over or hitting an animal on the road
Movement barrier	Preclusion of dispersal, migration or other movements as posed by a road itself or by human activities on or near a road or road network
Displacement or avoidance	Spatial shifts in populations or individual animals away from a road or road network in relation to human activities on or near a road or road network
Chronic negative interaction with humans	Increased mortality of animals due to increased contact with humans, as facilitated by road access

Table 107. Road density by subwatershed and multi-species matrix ratings (USFS 2003d).

Subwatershed[1]	Subwatershed Area (mi^2)	Road Length (mi)	Road Density (mi/mi^2)	Multi-species Matrix rating for Road Density and Drainage Network[2]
07A	4.5	3.3	0.7	Functioning at Risk
07B	20.6	24.7	1.2	not rated
07C	29.6	47.0	1.6	not rated
07D	19.4	19.9	1.0	Functioning at Unacceptable Risk
07E	23.3	24.1	1.0	Functioning at Risk
07F	12.2	13.6	1.1	not rated
07G	24.1	50.6	2.1	not rated
07H	38.0	59.4	1.6	Functioning at Risk
07I	11.4	10.7	0.9	Functioning Appropriately
07J	19.4	66.1	3.4	Functioning at Unacceptable Risk
07K	29.4	19.5	0.7	Functioning Appropriately
07L	9.9	24.5	2.5	Functioning at Unacceptable Risk
07M	22.4	50.4	2.3	Functioning at Risk
07N	10.4	18.7	1.8	Functioning Appropriately
07O	10.9	57.3	5.2	Functioning at Unacceptable Risk
07P	21.2	80.1	3.8	Functioning at Unacceptable Risk
07Q	16.0	53.9	3.4	Functioning at Unacceptable Risk
07R	19.1	21.4	1.1	Functioning at Risk
08A	8.8	8.5	1.0	Functioning Appropriately
08B	23.7	29.4	1.2	Functioning at Risk
08C	21.8	19.9	0.9	Functioning Appropriately
08D	19.7	13.2	0.7	Functioning Appropriately
08E	8.7	7.4	0.8	Functioning Appropriately

Subwatershed[1]	Subwatershed Area (mi^2)	Road Length (mi)	Road Density (mi/mi^2)	Multi-species Matrix rating for Road Density and Drainage Network[2]
08F	11.2	9.6	0.9	Functioning Appropriately
08G	34.4	17.6	0.5	Functioning Appropriately
08H	17.0	8.9	0.5	Functioning Appropriately
08I	18.3	2.0	0.1	not rated
08J	26.0	8.5	0.3	Functioning Appropriately
08K	18.6	9.6	0.5	Functioning Appropriately
08L	21.6	6.8	0.3	Functioning Appropriately
09A	35.9	41.7	1.2	Functioning Appropriately
09B	15.4	6.7	0.4	Functioning Appropriately
09C	14.1	11.0	0.8	Functioning Appropriately
09D	16.6	37.5	2.3	Functioning at Risk
09E	8.9	39.0	4.4	Functioning at Unacceptable Risk
09F	18.0	93.3	5.2	Functioning at Unacceptable Risk
09G	18.7	32.2	1.7	Functioning at Risk
09H	9.8	22.8	2.3	Functioning at Risk
09I	12.8	47.0	3.7	Functioning at Unacceptable Risk
09J	10.0	25.7	2.6	Functioning at Unacceptable Risk
09K	18.7	75.0	4.0	Functioning at Unacceptable Risk
09L	13.9	61.2	4.4	Functioning at Unacceptable Risk
09M	19.6	55.7	2.8	Functioning at Unacceptable Risk
09N	16.7	2.7	0.2	Functioning Appropriately
09O	21.3	0.0	0.0	Functioning Appropriately
09P	27.8	0.0	0.0	Functioning Appropriately

1 Subwatersheds of greatest concern in bold
2 Considers both road density and location and rates risk to various aquatic species. When ratings were different for the aquatic species the rating indicating the greater impact was used.

The WWNF through the CMP decision (2003a) plans to reduce open road density below 1.5 miles per square mile in the majority of sub-watersheds in the subbasin within the next 5 years. Objectives and strategies for further reducing road impacts and expanding road reduction efforts to private lands were developed by the Imnaha subbasin technical team and are presented in the Imnaha Subbasin Management Plan objective 19A.

Noxious weeds and other invasive plants

The introduction of nonnative plants to the Imnaha subbasin has reduced its ability to support native wildlife and plant species. Introduced plants in the subbasin often outcompete native plant species and alter ecological processes, thereby reducing habitat suitability (Quigley and Arbelbide 1997). Many invasive are not palatable to either livestock or wildlife, nor do they provide suitable habitat for wildlife species. For example, purple loosestrife is not readily eaten, nor does it provide nesting habitat. However, it replaces aquatic species that do provide quality habitat (USFS 2003a).

Weed problems in the subbasin are less severe than in many areas of the Columbia Basin but are most severe in the grassland habitats. The naturally open structure of the subbasin's grassland vegetation, its soils, and climate have predisposed it to invasion by weeds, especially by species of Mediterranean origin (USFS 2003a).

Noxious weed surveys conducted by the Wallowa-Whitman National Forest have documented the presence of 14 noxious weed species in the subbasin (see section 1.1.3.4 for details). Of these bugloss and Canada thistle cover the greatest number of acres. Additional survey effort is needed to document the extent of currently established noxious weed populations and to swiftly identify and treat new invasions in the subbasin.

Preventing the spread and establishment of noxious weeds and invasive plants in the subbasin is a high priority for the subbasins management agencies. Numerous federal, state, county, tribal and private organizations are working together in the area to coordinate weed education, prevention and control efforts including biological control insects and herbicide applications. Noxious weed control and eradication efforts are resource intensive, in order to most effectively employ these resources a prioritization of efforts is necessary. Wallowa County maintains a list of noxious weed priorities in the county, the 'A list' identifies the highest priority weed species for control or irradication in the county.

Highest	4 = Invasibility high, presence confirmed/probable, threat high, eradication/containment possible, and biocontrol not effective
	3 = Invasibility high, presence at least probable, threat high, containment may not be possible, and/or biocontrol possible
	2 = Invasibility and/or threat medium, containment impossible, or biocontrol effective
Low	1 = Invasibility and/or threat low, containment impossible, or biocontrol effective

Table 108. Wallowa County "A" List Noxious Weed Species

Wallowa County "A" List Noxious Weed Species		**East Canyons**	**Zumwalt**
Common Name	**Scientific Name**		
Common Bugloss*	Anchusa officianalis	4	3
Common Crupina	Crupina vulgaris	3	3
Dalmatian Toadflax*	Linaria dalmatica	4	3
Diffuse Knapweed	Centaurea diffusa	3	2
Japanese Knotweed	Polygonum cuspidatum	3	2
Jointed Goatgrass*	Aegilops cylindrica	3	3
Leafy Spurge	Euphorbia esula	4	4
Meadow Hawkweed*	Hieraceum pratense	4	4
Meadow Knapweed*	Centaurea pratensis	3	4
Mediterranean Sage*	Salvia aethiopis	3	3
Medusahead rye*	Taeniatherum caput-medusae	3	4
Musk Thistle*	Carduus nutans	2	4
Perennial Pepperweed*	Lepidium latifolium	4	4

Wallowa County "A" List Noxious Weed Species			
Purple Loosestrife*	Lythrum salicaria	3	3
Rush Skeletonweed*	Chondrilla juncea	4	4
Russian Knapweed	Centaurea repens	4	3
Scotch Thistle	Onopordum acanthium	3	3
Spotted Knapweed	Centaurea maculosa	4	4
Sulfur Cinquefoil	Potentilla recta	4	4
Tansy Ragwort*	Senecio jacobaea	4	3
Whitetop*	Cardaria draba	4	4
Yellow Starthistle	Centaurea solstitialis	3	4
Bloodrop/Pheasant Eye		?	4
Orange Hawkweed	Hieracium aurantiacum	4	3
Poison Hemlock	Conium maculatum	4	3
False Hoary Allysum		?	?
Yellow Toadflax*	Linaria Vulgaris	3	3

Table 109. Wallowa County "B" List Noxious Weed Species

Wallowa County "B" List Noxious Weed Species		East Canyons	Zumwalt
Common Name	Scientific Name		
Canada Thistle	Cirsium arvense	2	2
Chicory	Cichorium intybus	3	2
Common Burdock	Arctium minus	2	2
Common Teasle	Dipsacus fullonum	2	2
Field Bindweed	Convovulvis arvensis	3	3
Hounds Tongue	Cynglossum officinale	3	2
Kochia	Kochia scoparia	2	2
Mullen	Verbascum thapsis	2	2
Myrtle Spurge	Euphorbia sp.	4	3
Oxeye Daisy	Chrysanthemum leucanthemum	3	3
Puncture vine	Tribulus terrestris	3	2
Reed Canary Grass	Phalaris arundinacea	2	2
St. Johnswort	Hypericum perforatum	1	2
Western Waterhemlock	Cicuta douglasii	3	3
Ventenata	Ventenata dubia	3	3
Tall Buttercup	Rununculas acris	3	3
Bur Buttercup	Rununculas testiculatum	2	3

Table 110. Wallowa County Watch List Noxious Weed Species

Wallowa County Watch List Noxious Weed Species		East Canyons	Zumwalt
Common Name	Scientific Name		
Black Henbane	Hyoscyamus niger	1	1
Bouncing Bette	Saponaria officinalis	3	1
Buffalo Bur	Solanum rostratum	1	1
Common Cockle Bur	Xanthium strumarium	1	1
Dyers Woad	Isatis Tinctoria	2	2
Foxtail	Hordeum leporinum	2	2
Lambsquarter	Chenopodium berlandieri	2	2
Marsh Elder	Iva xanthofolia	2	2
Russian Thistle	Salsola iberica	3	3
Clary Sage	Salvia Pratensis	?	?
Salt Cedar	Tamarix ramosissima	2	2
Himalayan Blackberry	Rubis concolor	3	2
Russian Olive	Elaeagnus angustifloia	?	?

Strategies for preventing the establishment of new invasive species and reducing the rate of spread or eliminating established invaders were developed by the Imnaha subbasin technical team (objective 17A of the management plan). The introduction and spread of invasive species is tied to other activities in the subbasin including road construction and use, livestock grazing, fire, timber harvest and other soil disturbing activities. Strategies developed by the technical team to address these issues and included in the *Imnaha Subbasin Management Plan* will also help to reduce the impact of introduced plant species on the subbasin.

Loss of Marine-Derived Nutrients

The concept of Key Ecological Functions (KEFs) refers to the main ecological roles of a species or group of species that influence diversity, productivity or sustainability of ecosystems (see section 1.4.3 for details). Salmonids provide a variety of KEFs in the subbasin and across the Columbia Basin and form an important link between marine, freshwater aquatic and terrestrial environments. Anadromous salmon help to maintain ecosystem productivity and may be regarded as a keystone species. Salmon runs input organic matter and nutrients to the trophic system through multiple levels and pathways including direct consumption, excretion, decomposition, and primary production. Direct consumption occurs in the form of predation, parasitism, or scavenging of the live spawner, carcass, egg, or fry life stages. Carcass decomposition and the particulate and dissolved organic matter released by spawning fish deliver nutrients to primary producers (Cederholm et al. 2000). Relationships between wildlife species and salmon vary in terms of their strength; the categories that have been developed to characterize these relationships and are briefly described below see (Cederholm et al. 2000 and Johnson and O'Neil 2001 for more details):

- Strong-consistent relationship-Salmon play or historically played an important role in this species distribution viability, abundance and or population/status. The ecology of this wildlife species is supported by salmon, especially at particular lifestages or during specific seasons.
- Recurrent relationship- The relationship between salmon and this species is characterized as routine, albeit occasional, and often in localized areas (thus affecting only a small portion of this species population).
- Indirect relationship- Salmon play an important routine, but indirect link to this species. The relationship could be viewed as one of a secondary consumer of salmon; for example salmon support other wildlife that are prey of this species.
- Rare relationship- Salmon play a very minor role in the diet of these species often amounting to less than 1 percent of the diet.

Salmon fishes (including their eggs) are a major source of high-energy food that allows for successful reproduction and enhanced survival of many wildlife species. Sixty-seven birds, twenty-three mammals, three reptiles and one amphibian species thought to inhabit the Blue Mountain Province consume salmon during one or more of salmon's lifestages (IBIS 2003). Twenty-five of the ninety-four total species in the province with a relationship to salmon are concern or focal species, these species and their relationship to salmon are displayed in Table 88; species with more than one type of relationship consume salmon during multiple salmon lifestages. The reductions in the salmon runs of the subbasin described in section 1.2.3-1.2.5, have reduced nutrient inputs into the ecosystem and probably the suitability of the subbasin for many of the wildlife species that consume salmon. Strategies for restoring salmon runs and salmon habitat in the subbasin were developed by the aquatic subcommittee in objectives 1A-12A in the *Imnaha Subbasin Management Plan*. Strategies for reducing the impact of nutrient losses to the subbasin were developed by the terrestrial subcommittee in objective 20A in the management.

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2 Appendices

Appendix A Wildlife Species and Habitat Use, Imnaha Subbasin.

Appendix A Table 1.Wildlife species with potential habitat within the Imnaha subbasin and the wildlife habitat types (WHTs) with which they are closely associated (Johnson and O'Neil 2001, IBIS 2003).

Common Name		Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Long-toed salamander	*Ambystoma macrodactylum*								x	x	x
	Inland tailed frog	*Ascaphus montanus*	x									
	Western toad	*Bufo boreas*								x	x	x
	Pacific chorus (tree) frog	*Pseudacris regilla*								x	x	x
	Bullfrog	*Rana catesbeiana*								x	x	
	Columbia spotted frog	*Rana luteiventris*								x	x	
	Northern leopard frog	*Rana pipiens*								x	x	
	Great Basin spadefoot	*Scaphiopus intermontanus*								x	x	
8	**Total Amphibians**	**(number of amphibians closely associated with WHT)**	**1**							**7**	**7**	**3**
	Cooper's hawk	*Accipiter cooperii*										
	Northern goshawk	*Accipiter gentilis*		x	x							
	Sharp-shinned hawk	*Accipiter striatus*										
	Spotted sandpiper	*Actitis macularia*										
	Western grebe	*Aechmophorus occidentalis*								x	x	
	Northern saw-whet owl	*Aegolius acadicus*		x	x							
	Boreal owl	*Aegolius funereus*										
	White-throated swift	*Aeronautes saxatalis*										
	Red-winged blackbird	*Agelaius phoeniceus*									x	
	Wood duck	*Aix sponsa*								x		
	Chukar	*Alectoris chukar*					x	x				
	Grasshopper sparrow	*Ammodramus savannarum*					x		x			
	Sage sparrow	*Amphispiza belli*					x	x				
	Northern pintail	*Anas acuta*								x	x	

	Common Name	Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	American wigeon	*Anas americana*							x		x	
	Northern shoveler	*Anas clypeata*								x	x	
	Green-winged teal	*Anas crecca*									x	
	Cinnamon teal	*Anas cyanoptera*							x		x	
	Blue-winged teal	*Anas discors*							x		x	
	Eurasian wigeon	*Anas penelope*								x		
	Mallard	*Anas platyrhynchos*									x	
	Gadwall	*Anas strepera*								x	x	
	Greater white-fronted goose	*Anser albifrons*							x	x	x	
	American pipit	*Anthus rubescens*				x			x			
	Western scrub-jay	*Aphelocoma californica*										
	Golden eagle	*Aquila chrysaetos*										
	Black-chinned hummingbird	*Archilochus alexandri*										
	Great egret	*Ardea alba*								x	x	
	Great blue heron	*Ardea herodias*							x	x	x	
	Short-eared owl	*Asio flammeus*							x		x	
	Long-eared owl	*Asio otus*						x				
	Burrowing owl	*Athene cunicularia*					x	x				
	Lesser scaup	*Aythya affinis*								x	x	
	Redhead	*Aythya americana*								x	x	
	Ring-necked duck	*Aythya collaris*										
	Greater scaup	*Aythya marila*								x		
	Canvasback	*Aythya valisineria*								x	x	
	Upland sandpiper	*Bartramia longicauda*					x					
	Cedar waxwing	*Bombycilla cedrorum*										
	Bohemian waxwing	*Bombycilla garrulus*										
	Ruffed grouse	*Bonasa umbellus*										
	American bittern	*Botaurus lentiginosus*									x	

	Common Name	Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Canada goose	*Branta canadensis*							x	x	x	
	Great horned owl	*Bubo virginianus*										
	Bufflehead	*Bucephala albeola*	x							x	x	x
	Common goldeneye	*Bucephala clangula*								x		
	Barrow's goldeneye	*Bucephala islandica*	x							x		
	Red-tailed hawk	*Buteo jamaicensis*					x	x				
	Rough-legged hawk	*Buteo lagopus*										
	Ferruginous hawk	*Buteo regalis*					x	x				
	Swainson's hawk	*Buteo swainsoni*					x	x	x			
	Green heron	*Butorides virescens*									x	
	Sanderling	*Calidris alba*										
	Dunlin	*Calidris alpina*							x	x	x	
	Baird's sandpiper	*Calidris bairdii*									x	
	Stilt sandpiper	*Calidris himantopus*								x		
	Western sandpiper	*Calidris mauri*								x	x	
	Pectoral sandpiper	*Calidris melanotos*									x	
	Least sandpiper	*Calidris minutilla*									x	
	Semipalmated sandpiper	*Calidris pusilla*								x		
	California quail	*Callipepla californica*										
	Common redpoll	*Carduelis flammea*										
	Pine siskin	*Carduelis pinus*										
	Lesser goldfinch	*Carduelis psaltria*										
	American goldfinch	*Carduelis tristis*										
	Cassin's finch	*Carpodacus cassinii*										
	House finch	*Carpodacus mexicanus*							x			
	Purple finch	*Carpodacus purpureus*										
	Turkey vulture	*Cathartes aura*										
	Hermit thrush	*Catharus guttatus*										

Common Name		Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Swainson's thrush	*Catharus ustulatus*										
	Canyon wren	*Catherpes mexicanus*										
	Willet	*Catoptrophorus semipalmatus*						x	x		x	
	Greater sage-grouse	*Centrocercus urophasianus*					x	x				
	Brown creeper	*Certhia americana*										
	Belted kingfisher	*Ceryle alcyon*								x		
	Vaux's swift	*Chaetura vauxi*								x		
	Semipalmated plover	*Charadrius semipalmatus*								x		
	Killdeer	*Charadrius vociferus*							x			
	Snow goose	*Chen Ccaerulescens*							x	x	x	
	Ross's goose	*Chen rossii*							x	x	x	
	Black tern	*Chlidonias niger*									x	
	Lark sparrow	*Chondestes grammacus*						x				
	Common nighthawk	*Chordeiles minor*										
	American dipper	*Cinclus mexicanus*								x		
	Northern harrier	*Circus cyaneus*										
	Marsh wren	*Cistothorus palustris*									x	
	Evening grosbeak	*Coccothraustes vespertinus*	x									x
	Northern flicker	*Colaptes auratus*										
	Northern bobwhite	*Colinus virginianus*					x		x			
	Band-tailed pigeon	*Patagioenas fasciata*										
	Rock pigeon	*Columba livia*							x			
	Olive-sided flycatcher	*Contopus cooperi*	x	x								
	Western wood-pewee	*Contopus sordidulus*										
	American crow	*Corvus brachyrhynchos*							x			
	Common raven	*Corvus corax*										
	Steller's jay	*Cyanocitta stelleri*										
	Trumpeter swan	*Cygnus buccinator*							x	x	x	

	Common Name	Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Tundra swan	*Cygnus columbianus*							x	x	x	
	Black swift	*Cypseloides niger*										
	Blue grouse	*Dendragapus obscurus*		x	x							
	Yellow-rumped warbler	*Dendroica coronata*										
	Townsend's warbler	*Dendroica townsendi*										
	Bobolink	*Dolichonyx oryzivorus*							x			
	Pileated woodpecker	*Dryocopus pileatus*										
	Gray catbird	*Dumetella carolinensis*										
	Hammond's flycatcher	*Empidonax hammondii*										
	Least flycatcher	*Empidonax minimus*										
	Dusky flycatcher	*Empidonax oberholseri*										
	Cordilleran flycatcher	*Empidonax occidentalis*										
	Willow flycatcher	*Empidonax traillii*										
	Gray flycatcher	*Empidonax wrightii*										
	Horned lark	*Eremophila alpestris*					x					
	Brewer's blackbird	*Euphagus cyanocephalus*							x			
	Spruce grouse	*Falcipennis canadensis*										
	Merlin	*Falco columbarius*										
	Prairie falcon	*Falco mexicanus*					x	x				
	Peregrine falcon	*Falco peregrinus*										
	Gyrfalcon	*Falco rusticolus*										
	American kestrel	*Falco sparverius*										
	American coot	*Fulica americana*								x	x	
	Common snipe	*Gallinago gallinago*							x		x	
	Common loon	*Gavia immer*									x	
	Common yellowthroat	*Geothlypis trichas*									x	
	Northern pygmy-owl	*Glaucidium gnoma*		x								
	Sandhill crane	*Grus canadensis*							x		x	

	Common Name	Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Pinyon jay	*Gymnorhinus cyanocephalus*										
	Bald eagle	*Haliaeetus leucocephalus*								x		
	Black-necked stilt	*Himantopus mexicanus*								x	x	
	Barn swallow	*Hirundo rustica*							x		x	
	Harlequin duck	*Histrionicus histrionicus*								x		
	Yellow-breasted chat	*Icteria virens*										
	Bullock's oriole	*Icterus bullockii*										
	Varied thrush	*Ixoreus naevius*	x	x								
	Dark-eyed junco	*Junco hyemalis*										
	Northern shrike	*Lanius excubitor*					x	x	x			
	Loggerhead shrike	*Lanius ludovicianus*						x	x			
	Herring gull	*Larus argentatus*								x		
	California gull	*Larus californicus*								x		
	Ring-billed gull	*Larus delawarensis*								x		
	Bonaparte's gull	*Larus philadelphia*										
	Franklin's gull	*Larus pipixcan*									x	
	Black rosy-finch	*Leucosticte atrata*				x						
	Gray-crowned rosy-finch	*Leucosticte tephrocotis*				x						
	Short-billed dowitcher	*Limnodromus griseus*										
	Long-billed dowitcher	*Limnodromus scolopaceus*							x		x	
	Marbled godwit	*Limosa fedoa*								x		
	Hooded merganser	*Lophodytes cucullatus*								x		
	Red crossbill	*Loxia curvirostra*										
	White-winged crossbill	*Loxia leucoptera*	x									
	Lewis's woodpecker	*Melanerpes lewis*										
	Surf scoter	*Melanitta perspicillata*										
	Wild turkey	*Meleagris gallopavo*										
	Swamp sparrow	*Melospiza georgiana*									x	

Common Name	Species Name	WHT with which Species Is Closely Associated[1]									
		4	5	7	10	15	16	19	21	22	24
Lincoln's sparrow	*Melospiza lincolnii*									x	
Song sparrow	*Melospiza melodia*										
Common merganser	*Mergus merganser*								x		
Northern mockingbird	*Mimus polyglottos*										
Brown-headed cowbird	*Molothrus ater*							x			
Townsend's solitaire	*Myadestes townsendi*										
Ash-throated flycatcher	*Myiarchus cinerascens*										
Clark's nutcracker	*Nucifraga columbiana*										
Long-billed curlew	*Numenius americanus*					x	x	x			
Snowy owl	*Nyctea scandiaca*										
Black-crowned night-heron	*Nycticorax nycticorax*								x	x	
MacGillivray's warbler	*Oporornis tolmiei*										
Mountain quail	*Oreortyx pictus*										
Sage thrasher	*Oreoscoptes montanus*						x				
Flammulated owl	*Otus flammeolus*		x	x							
Western screech-owl	*Otus kennicottii*										
Ruddy duck	*Oxyura jamaicensis*								x	x	
Osprey	*Pandion haliaetus*								x		
House sparrow	*Passer domesticus*							x			
Savannah sparrow	*Passerculus sandwichensis*					x		x			
Fox sparrow	*Passerella iliaca*	x	x	x							
Lazuli bunting	*Passerina amoena*							x			
American white pelican	*Pelecanus erythrorhynchos*								x		
Gray partridge	*Perdix perdix*							x			
Gray jay	*Perisoreus canadensis*	x									
Cliff swallow	*Petrochelidon pyrrhonota*								x		
Double-crested cormorant	*Phalacrocorax auritus*								x		
Common poorwill	*Phalaenoptilus nuttallii*										

Common Name		Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Wilson's phalarope	*Phalaropus tricolor*								x	x	
	Ring-necked pheasant	*Phasianus colchicus*							x			
	Black-headed grosbeak	*Pheucticus melanocephalus*										
	Black-billed magpie	*Pica pica*							x			
	White-headed woodpecker	*Picoides albolarvatus*			x							
	Black-backed woodpecker	*Picoides arcticus*										
	Downy woodpecker	*Picoides pubescens*										
	Three-toed woodpecker	*Picoides tridactylus*										
	Hairy woodpecker	*Picoides villosus*										
	Pine grosbeak	*Pinicola enucleator*	x									
	Green-tailed towhee	*Pipilo chlorurus*	x	x								
	Spotted towhee	*Pipilo maculatus*										
	Western tanager	*Piranga ludoviciana*	x	x	x							
	Snow bunting	*Plectrophenax nivalis*										
	Black-bellied plover	*Pluvialis squatarola*							x	x		
	Horned grebe	*Podiceps auritus*								x	x	
	Red-necked grebe	*Podiceps grisegena*								x	x	
	Eared grebe	*Podiceps nigricollis*								x	x	
	Pied-billed grebe	*Podilymbus podiceps*									x	
	Black-capped chickadee	*Poecile atricapillus*										
	Mountain chickadee	*Poecile gambeli*										
	Chestnut-backed chickadee	*Poecile rufescens*										
	Vesper sparrow	*Pooecetes gramineus*					x	x	x			
	Sora	*Porzana carolina*									x	
	Bushtit	*Psaltriparus minimus*										
	Virginia rail	*Rallus limicola*									x	
	American avocet	*Recurvirostra americana*								x	x	
	Ruby-crowned kinglet	*Regulus calendula*										

	Common Name	Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Golden-crowned kinglet	*Regulus satrapa*	x	x								
	Bank swallow	*Riparia riparia*								x		
	Rock wren	*Salpinctes obsoletus*										
	Say's phoebe	*Sayornis saya*					x	x				
	Rufous hummingbird	*Selasphorus rufus*										
	Mountain bluebird	*Sialia currucoides*										
	Western bluebird	*Sialia mexicana*			x							
	Red-breasted nuthatch	*Sitta canadensis*										
	White-breasted nuthatch	*Sitta carolinensis*			x							
	Pygmy nuthatch	*Sitta pygmaea*			x							
	Red-naped sapsucker	*Sphyrapicus nuchalis*										
	Red-breasted sapsucker	*Sphyrapicus ruber*										
	Williamson's sapsucker	*Sphyrapicus thyroideus*										
	American tree sparrow	*Spizella arborea*										
	Brewer's sparrow	*Spizella breweri*						x				
	Clay-colored sparrow	*Spizella pallida*										
	Chipping sparrow	*Spizella passerina*										
	northern rough-winged swallow	*Stelgidopteryx serripennis*								x	x	
	Calliope hummingbird	*Stellula calliope*										
	Caspian tern	*Sterna caspia*								x	x	
	Forster's tern	*Sterna forsteri*								x	x	
	Common tern	*Sterna hirundo*										
	Great gray owl	*Strix nebulosa*			x							
	Barred owl	*Strix varia*		x								
	Western meadowlark	*Sturnella neglecta*					x	x	x			
	European starling	*Sturnus vulgaris*							x			
	Tree swallow	*Tachycineta bicolor*								x	x	
	Violet-green swallow	*Tachycineta thalassina*										

Common Name		Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Bewick's wren	*Thryomanes bewickii*										
	Lesser yellowlegs	*Tringa flavipes*								x	x	
	Greater yellowlegs	*Tringa melanoleuca*								x	x	
	Solitary sandpiper	*Tringa solitaria*							x			
	House wren	*Troglodytes aedon*										
	Winter wren	*Troglodytes troglodytes*										
	American robin	*Turdus migratorius*										
	Sharp-tailed grouse	*Tympanuchus phasianellus*					x	x				
	Eastern kingbird	*Tyrannus tyrannus*					x					
	Western kingbird	*Tyrannus verticalis*					x					
	Barn owl	*Tyto alba*							x			
	Orange-crowned warbler	*Vermivora celata*										
	Nashville warbler	*Vermivora ruficapilla*										
	Cassin's vireo	*Vireo cassinii*			x							
	Warbling vireo	*Vireo gilvus*										
	Wilson's warbler	*Wilsonia pusilla*										
	Yellow-headed blackbird	*Xanthocephalus xanthocephalus*									x	
	Mourning dove	*Zenaida macroura*							x			
	White-throated sparrow	*Zonotrichia albicollis*										
	Golden-crowned sparrow	*Zonotrichia atricapilla*				x						
	White-crowned sparrow	*Zonotrichia leucophrys*										
	Harris's sparrow	*Zonotrichia querula*										
260	**Total Birds**	**(number of birds closely associated with WHT)**	**12**	**12**	**12**	**4**	**21**	**20**	**44**	**58**	**61**	**2**
	Pronghorn	*Antilocapra americana*					x	x				
	Pallid bat	*Antrozous pallidus*						x		x	x	
	Pygmy rabbit	*Brachylagus idahoensis*						x				
	Coyote	*Canis latrans*										
	Wolf	*Canis lupus* (suspected)										

	Common Name	Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	American beaver	*Castor canadensis*								x	x	
	Elk	*Cervus elaphus*										
	Southern red-backed vole	*Clethrionomys gapperi*	x	x								x
	Townsend's big-eared bat	*Corynorhinus townsendii*								x		
	Virginia opossum	*Didelphis virginiana*							x			
	Ord's kangaroo rat	*Dipodomys ordii*						x				
	Big brown bat	*Eptesicus fuscus*	x	x	x				x			x
	Common porcupine	*Erethizon dorsatum*	x	x	x							
	Northern flying squirrel	*Glaucomys sabrinus*	x	x								
	Silver-haired bat	*Lasionycteris noctivagans*		x	x							
	Hoary bat	*Lasiurus cinereus*										
	Sagebrush vole	*Lemmiscus curtatus*						x				
	Snowshoe hare	*Lepus americanus*	x	x								x
	Black-tailed jackrabbit	*Lepus californicus*						x				
	White-tailed jackrabbit	*Lepus townsendii*					x					
	Northern river otter	*Lutra canadensis*								x	x	
	Lynx	*Lynx canadensis*		x								
	Bobcat	*Lynx rufus*										
	Yellow-bellied marmot	*Marmota flaviventris*										
	American marten	*Martes americana*	x	x								
	Striped skunk	*Mephitis mephitis*										
	Long-tailed vole	*Microtus longicaudus*									x	x
	Montane vole	*Microtus montanus*					x		x		x	
	Water vole	*Microtus richardsoni*				x						x
	House mouse	*Mus musculus*							x			
	Ermine	*Mustela erminea*										
	Long-tailed weasel	*Mustela frenata*										
	Mink	*Mustela vison*								x	x	

	Common Name	Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	California myotis	*Myotis californicus*		x								
	Western small-footed myotis	*Myotis ciliolabrum*					x	x		x	x	
	Long-eared myotis	*Myotis evotis*										
	Little brown myotis	*Myotis lucifugus*										
	Fringed myotis	*Myotis thysanodes*										
	Long-legged myotis	*Myotis volans*	x	x	x							
	Yuma myotis	*Myotis yumanensis*								x	x	x
	Bushy-tailed woodrat	*Neotoma cinerea*	x	x					x			
	American pika	*Ochotona princeps*				x						
	Mule deer	*Odocoileus hemionus*										
	White-tailed deer	*Odocoileus virginianus*							x			
	Muskrat	*Ondatra zibethicus*								x		
	Northern grasshopper mouse	*Onychomys leucogaster*						x				
	Rocky Mountain goat	*Oreamnos americanus*				x						
	Bighorn sheep	*Ovis canadensis*										
	Great Basin pocket mouse	*Perognathus parvus*						x				
	Canyon mouse	*Peromyscus crinitus*										
	Deer mouse	*Peromyscus maniculatus*		x	x		x	x	x		x	x
	Heather vole	*Phenacomys intermedius*	x	x		x						
	Western pipistrelle	*Pipistrellus hesperus*					x	x		x		
	Raccoon	*Procyon lotor*							x		x	
	Mountain lion	*Puma concolor*										
	Norway rat	*Rattus norvegicus*										
	Western harvest mouse	*Reithrodontomys megalotis*						x			x	
	Coast mole	*Scapanus orarius*	x	x								
	Eastern fox squirrel	*Sciurus niger*							x			
	Merriam's shrew	*Sorex merriami*						x				
	Water shrew	*Sorex palustris*	x									x

Common Name		Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Preble's shrew	*Sorex preblei*										
	Vagrant shrew	*Sorex vagrans*										
	Belding's ground squirrel	*Spermophilus beldingi*				x	x	x	x			
	Merriam's ground squirrel	*Spermophilus canus*										
	Columbian ground squirrel	*Spermophilus columbianus*	x	x	x	x	x					
	Golden-mantled ground squirrel	*Spermophilus lateralis*	x	x	x							
	Piute ground squirrel	*Spermophilus mollis*						x				
	Western spotted skunk	*Spilogale gracilis*										
	Nuttall's (mountain) cottontail	*Sylvilagus nuttallii*					x	x				
	Yellow-pine chipmunk	*Tamias amoenus*			x							
	Least chipmunk	*Tamias minimus*						x				
	Douglas's squirrel	*Tamiasciurus douglasii*										
	Red squirrel	*Tamiasciurus hudsonicus*		x								
	American badger	*Taxidea taxus*					x	x				
	Northern pocket gopher	*Thomomys talpoides*		x	x		x		x			
	Black bear	*Ursus americanus*										
	Grizzly bear	*Ursus arctos*										
	Red fox	*Vulpes vulpes*				x						
	Western jumping mouse	*Zapus princeps*				x						
80	**Total Mammals**	**(number of mammals closely associated with WHT)**	**13**	**18**	**9**	**8**	**11**	**18**	**11**	**9**	**11**	**8**
	Rubber boa	*Charina bottae*										
	Painted turtle	*Chrysemys picta*								x	x	
	Western whiptail	*Cnemidophorus tigris*										
	Racer	*Coluber constrictor*										
	Western rattlesnake	*Crotalus viridis*										
	Western skink	*Eumeces skiltonianus*										
	Desert horned lizard	*Phrynosoma platyrhinos*										

Common Name		Species Name	WHT with which Species Is Closely Associated[1]									
			4	5	7	10	15	16	19	21	22	24
	Gopher snake	*Pituophis catenifer*										
	Sagebrush lizard	*Sceloporus graciosus*										
	Western fence lizard	*Sceloporus occidentalis*										
	Common garter snake	*Thamnophis sirtalis*									x	x
11	**Total Reptiles**	**(number of mammals closely associated with WHT)**								**1**	**2**	**1**
359	**Total Wildlife Species**	**(number of wildlife species closely associated with WHT)**	**26**	**30**	**21**	**12**	**32**	**38**	**55**	**75**	**81**	**14**

WHT Key[1]	
4—Montane Mixed Conifer	16—Shrub-steppe
5—Interior Eastside Mixed Conifer	191—Agriculture
7—Ponderosa Pine	21—Open Water
10—Alpine Grasslands and Shrublands	22—Herbaceous Wetlands
15—Interior Grasslands	24—Montane Coniferous Wetlands

Appendix B Information on the grazing allotments of the Imnaha subbasin.

Appendix Table 2. Use intensity, use timing, and features of the grazing allotment of the Imnaha subbasin.

Allotment Name	Number of Pastures	Livestock Kind/Class	Permit Type	Animal Numbers Permitted	Season of Use	Listed Fish Habitat	Acres	Percent Suitable Grazing Lands
Bear Gulch	5	Cattle, cow/calf	Term grazing	124 pair	4/16–11/10	y	9,550	85
			Term private land (waived)	19 pair				
Big sheep	4	Cattle, cow/calf	Term grazing	350	4/16–6/30	y	20,762	77
				300	11/1–12/31			
			Term private land (waived)	100	5/1–6/30			
				100	11/1–12/31			
Blackmore	2	Cattle, cow/calf	Term grazing	64 pair	4/16–5/15 and 11/16–12/15	n	823	46
			Term private land (waived)	21 pair				
Carrol Creek	7	Cattle, cow/calf	Term grazing	58 pair	4/25–5/10	y	3,173	54
				22 pair	6/1–7/31			
				51 pair	11/1–12/15			
			Term grazing with on-off provisions (not waived)	140 pair	4/25–5/10			
				140 pair	6/1–7/31			
				82 pair	11/1–12/15			
Cayuse	7	Cattle, cow/calf	Term grazing	348 pair	4/16–12/15	y	42,413	65
			Term private land (waived)	52 pair				
Chalk	4	Cattle, cow/calf		93 pair	4/16–5/15	n	2,207	66
			Term grazing	20 pair	5/16–10/30			
				93 pair	11/11–12/20			
			Term private land	17 pair	4/16–5/15			
			(waived)	30 pair	5/16–10/30			
				17 pair	11/11–12/20			

Allotment Name	Number of Pastures	Livestock Kind/Class	Permit Type	Animal Numbers Permitted	Season of Use	Listed Fish Habitat	Acres	Percent Suitable Grazing Lands
College	2	Cattle, cow/calf	Term grazing	30 pair	4/16–5/15 and 11/1–11/30	n	669	38
Cow Creek	6	Cattle, cow/calf	Term grazing	231pair	11/1–12/31and 2/1–5/15	y	7,363	66
			Term private land	38 pair	11/1–12/31and 3/1–5/15			
Divide	6	Cattle, cow/calf	Term grazing	225 pair	6/11–10/21	y	16,717	78
Dodson Hass	23	Cattle, cow/calf	Term grazing	507 pair	11/1–12/31and 2/1–5/15	y	10,397	98
			Term private land (waived)	158 pair	11/1–12/31 and 3/1–5/15			
Dunlap Thorn	3	Cattle, cow/calf	Term grazing	150 pair	11/11–12/20 and5/1–5/30	n	2,309	97
			Term private land (waived)	35 pair				
Dunn Creek	1	Cattle, cow/calf	Term grazing	32 pair	11/1–11/30 and 4/16–5/15	n	319	56
Grizzly Ridge	1	Cattle, cow/calf	Term grazing	46 pair	4/16–7/15	n	3,802	100
			Term grazing permit with on-off provisions (not waived)	186				
Grouse-line	7	Cattle, cow/calf	Term grazing	130 pair	4/16–5/15	y	13,815	94
				151 pair	5/16–10/31			
				467 pair	11/1–11/30			
			Term private land (waived)	170 pair	4/16–5/15			
				63 pair	5/16–10/31			
				524 pair	11/1–11/30			
Horse Creek	5	Cattle, cow/calf	Term grazing	192 pair	3/16–6/15	y	8,723	59
				234 pair	10/28–11/30			

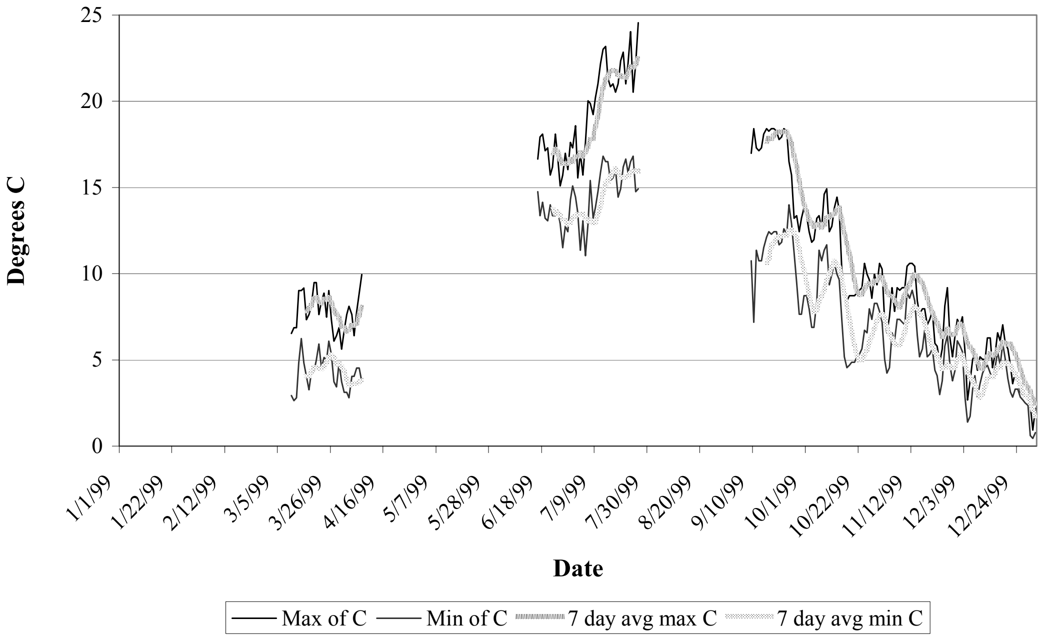
Allotment Name	Number of Pastures	Livestock Kind/Class	Permit Type	Animal Numbers Permitted	Season of Use	Listed Fish Habitat	Acres	Percent Suitable Grazing Lands
Keeler	4	Horses	Term grazing	2 head	11/16–4/30	n	310	100
			Term grazing permit with on-off provisions (not waived)	2 head				
Log Creek	6	Cattle, cow/calf	Term grazing	247 pair	Variable Totals 5.3 months within 3/1–1/31	y	10,312	72
			Term Private Land (waived)	150 pair	Variable Totals 5.3 months within 3/1–1/31			
Lone Pine	1	Cattle, cow/calf	Term Grazing	300 pair	12/1–5/31	n	10,839	73
		Horses/Mules		6 head				
Mar Flat	16	Cattle, cow/calf	Term grazing	100 pair	7/1–10/31	y	85,740	48
				1021pair	5/16–10/31			
		Horse/Mule	Term grazing	4 head	6/1–10/31			
				6 head	6/1–10/15			
Middle point	9	Cattle, cow/calf	Term grazing	132 pair	4/16–5/31 and	y	5,280	67
				16 pair	11/16–11/30			
			Private land (waived)	118 pair	4/16–5/31			
Mink	1	Cattle, cow/calf	Term grazing	25 pair	6/1–8/30	n	644	47
			Term private land (waived)	25 pair				
Needham	2	Cattle, cow/calf	Term private land (waived)	35 pair	5/1–10/31	y	1,634	65
Rhodes Creek	16	Cattle, cow/calf	Term grazing	784 pair	11/1–2/15	y	28,634	73
				500 pair	2/16–4/15			
				784 pair	4/16–5/15			
			Term private land (waived)	101 pair	11/1–2/15			
				64 pair	2/16–4/15			

Allotment Name	Number of Pastures	Livestock Kind/Class	Permit Type	Animal Numbers Permitted	Season of Use	Listed Fish Habitat	Acres	Percent Suitable Grazing Lands
				101 pair	4/16–5/15			
		Horses/Mules	Term grazing	15 head	11/1–5/15			
Saddle Creek	7	Cattle, cow/calf	Term grazing	100 pair	5/16–10/31	y	18,202	47
Schleur	5	Cattle, cow/calf	Term grazing	100 pair	4/16–5/15 and 11/1–11/30	n	2,851	28
			Private land (not waived)	20 pair				
Snell	2	Cattle, cow/calf	Term grazing	100 pair	4/16–5/15 and 11/1–11/30	n	1,317	43
Toomey	8	Cattle, cow/calf	Term grazing	184 pair	11/1–12/31 and 2/1–5/15	n	5,538	85
			Term private land (waived)	52	11/1–12/31and 3/1–5/15			
College	1	Horses & Mules	N/A	5–20 head	5/1–11/30, as needed	n	700	NA
Thorn Creek Horse	2	Horses & Mules	N/A	5–20 head	As needed	n	100	NA
Lick Creek	1	Horses & Mules	N/A	4–10 head	7/16–11/15	n	12	NA
Memaloose	1	Horses & Mules	N/A	5–20 head	6/1–10/31	y	1,080	NA
Lord Flat	1	Horses & Mules	N/A	5–20 head	6/1–10/31	n	1,800	NA

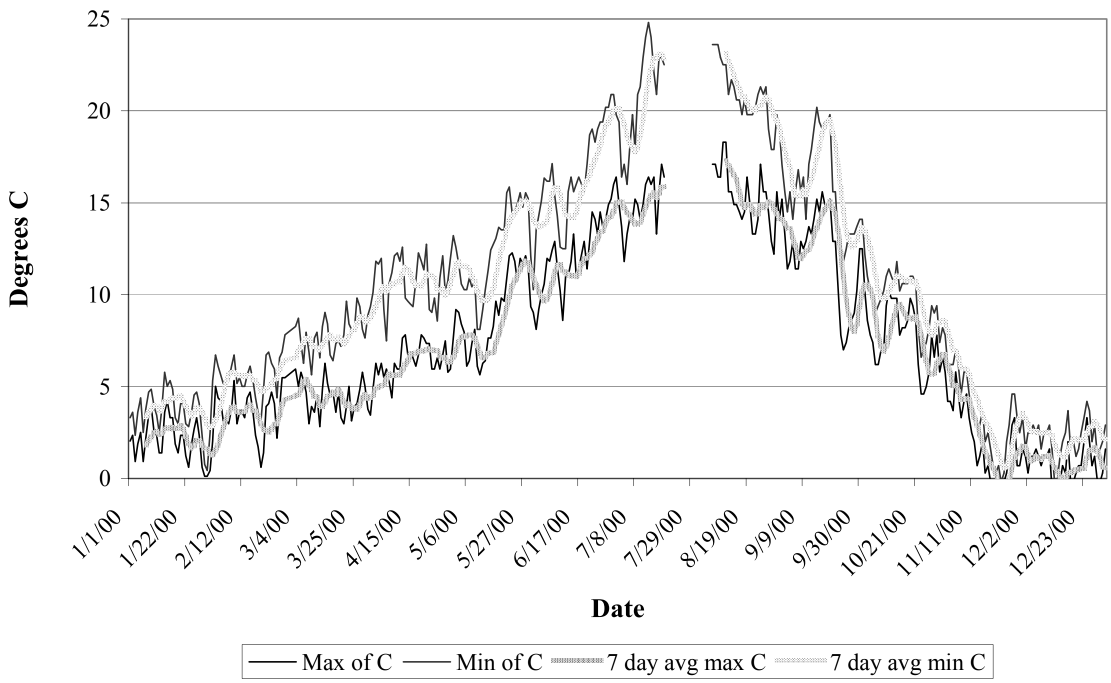
Appendix C Continuous water temperature monitoring data (1999-2003) for select tributaries and mainstem reaches in the Lower Imnaha, Big Sheep Creek, and Upper Imnaha watersheds

Lower Imnaha Watershed, Water Temperatures:

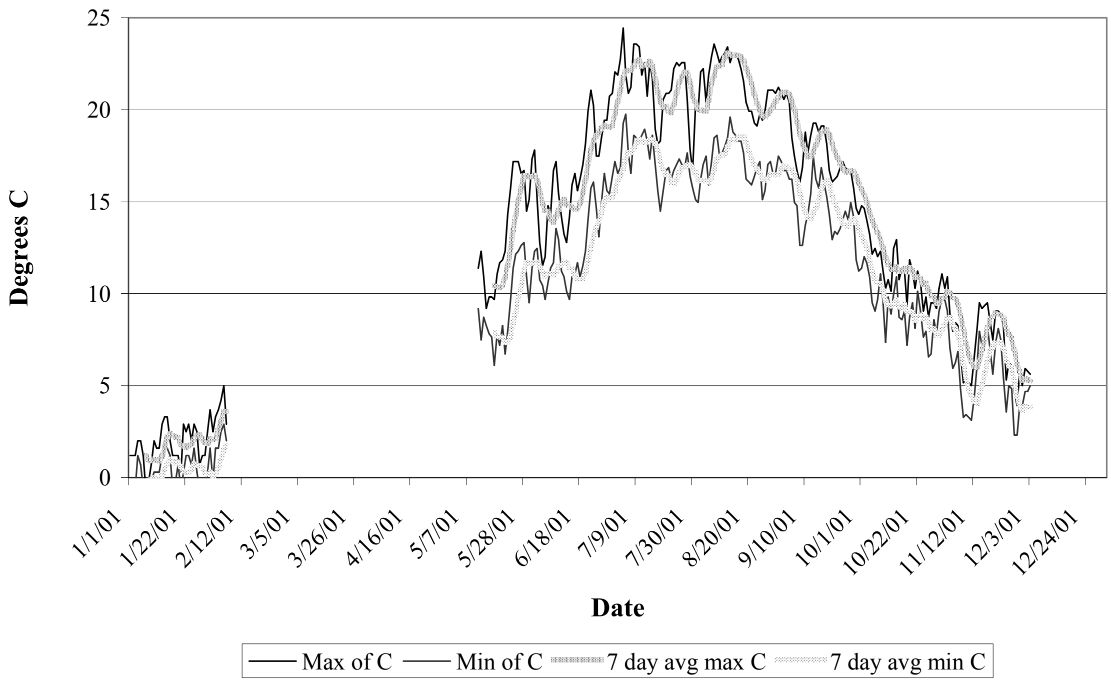
Cow Creek water temperature 1999



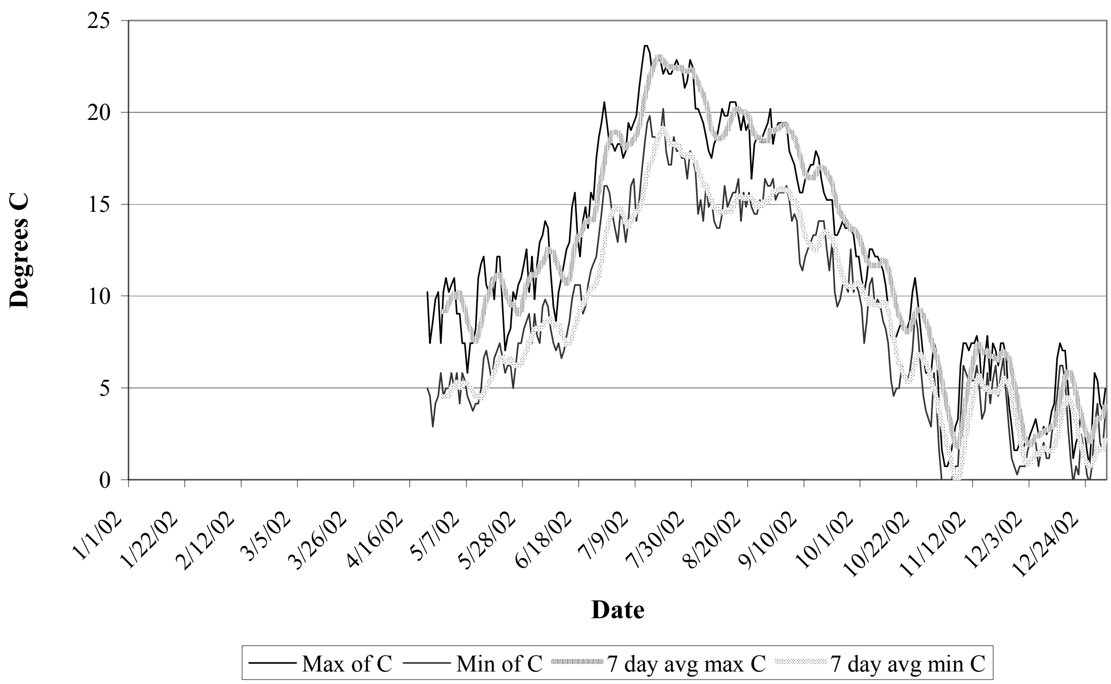
Cow Creek water temperature 2000



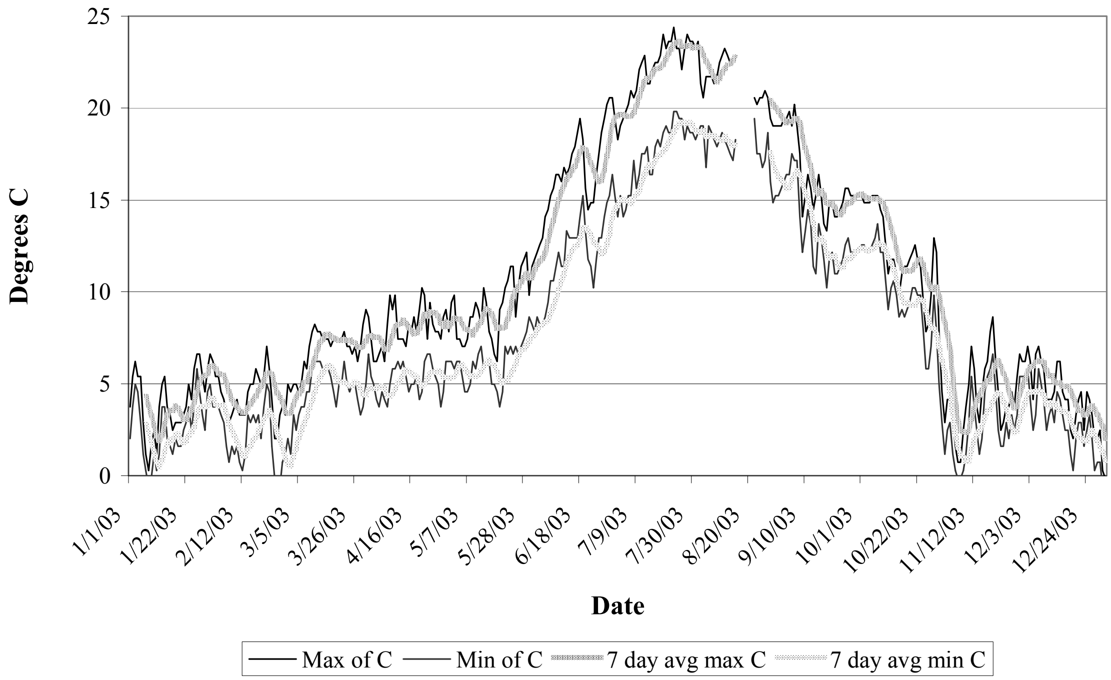
Cow Creek water temperature 2001



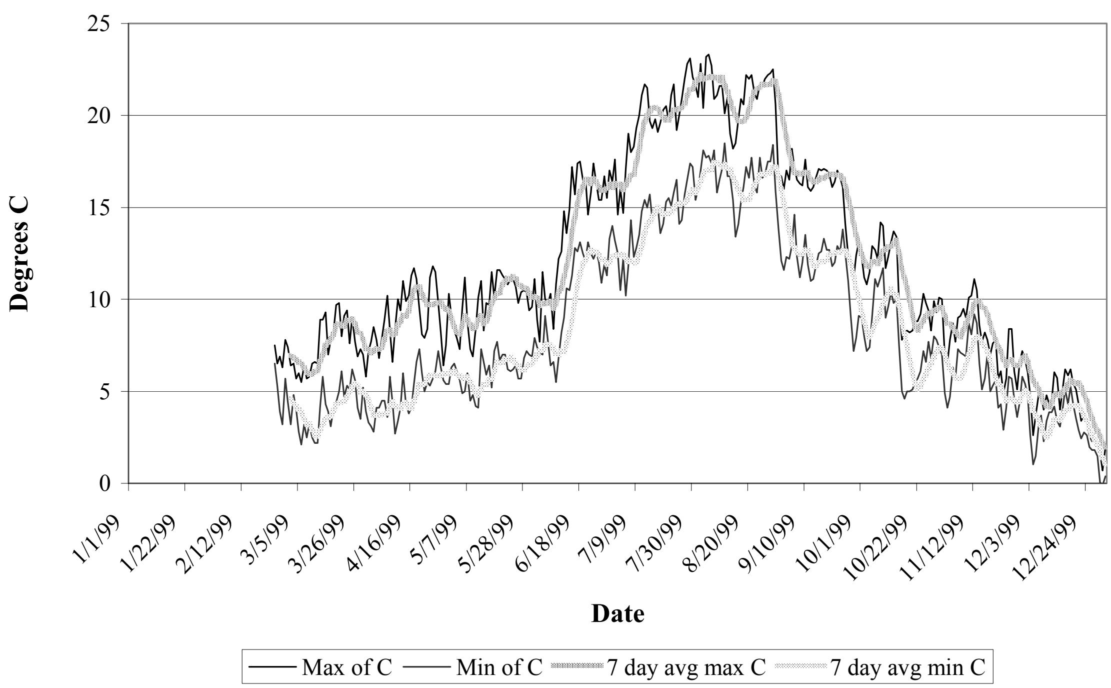
Cow Creek water temperature 2002



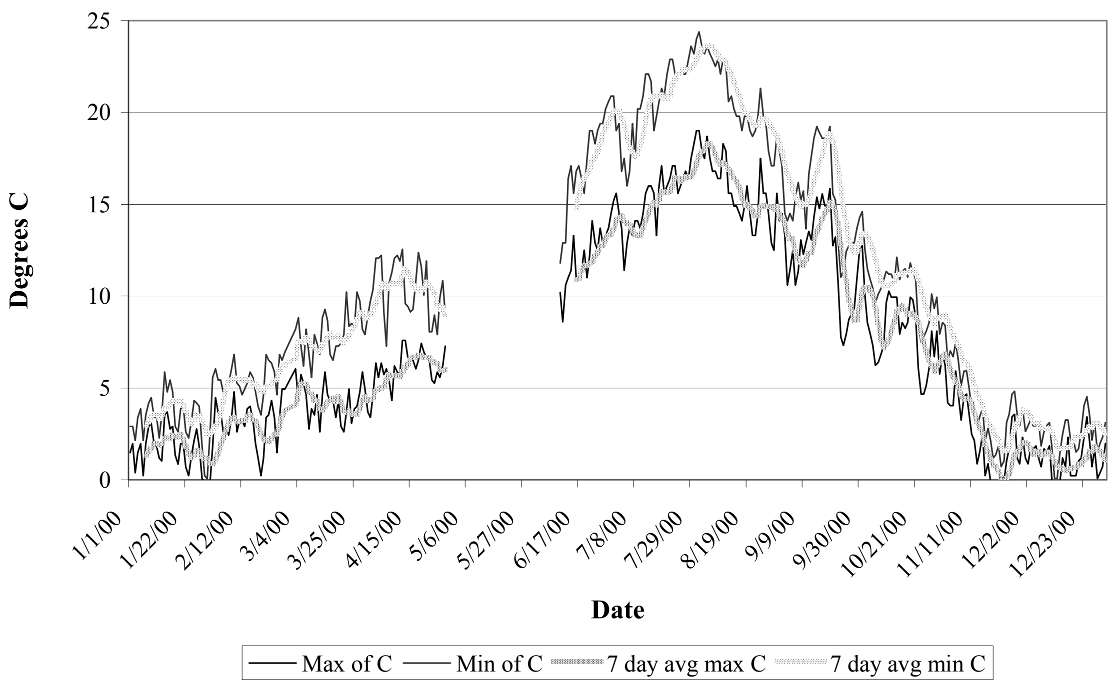
Cow Creek water temperature 2003



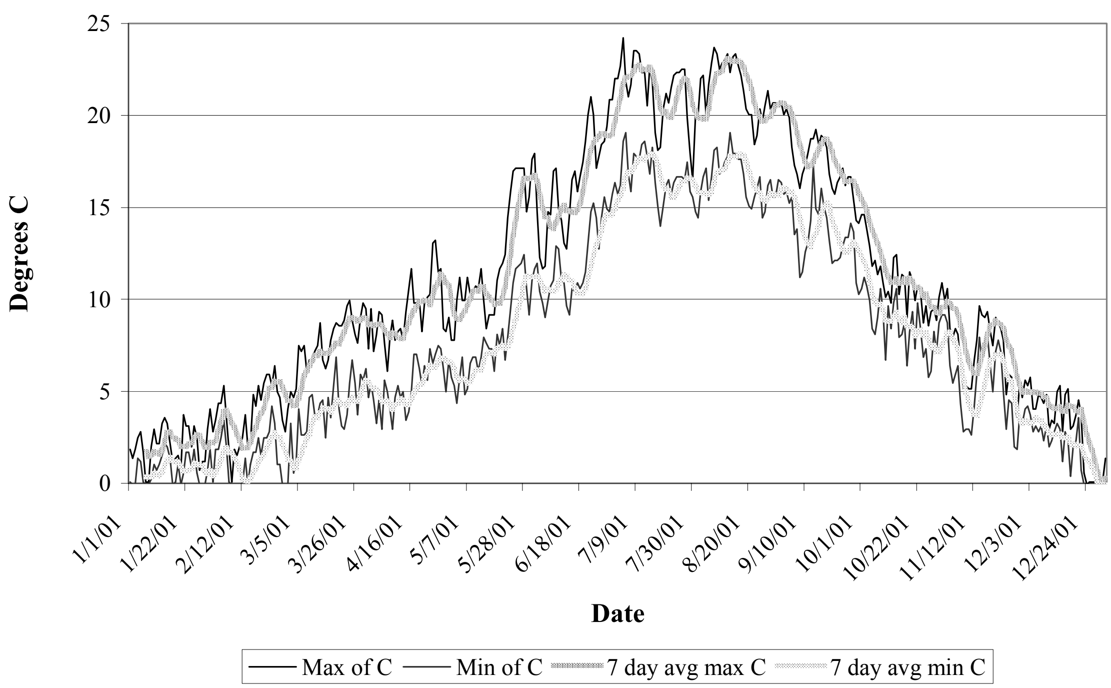
Lightning Creek water temperature 1999



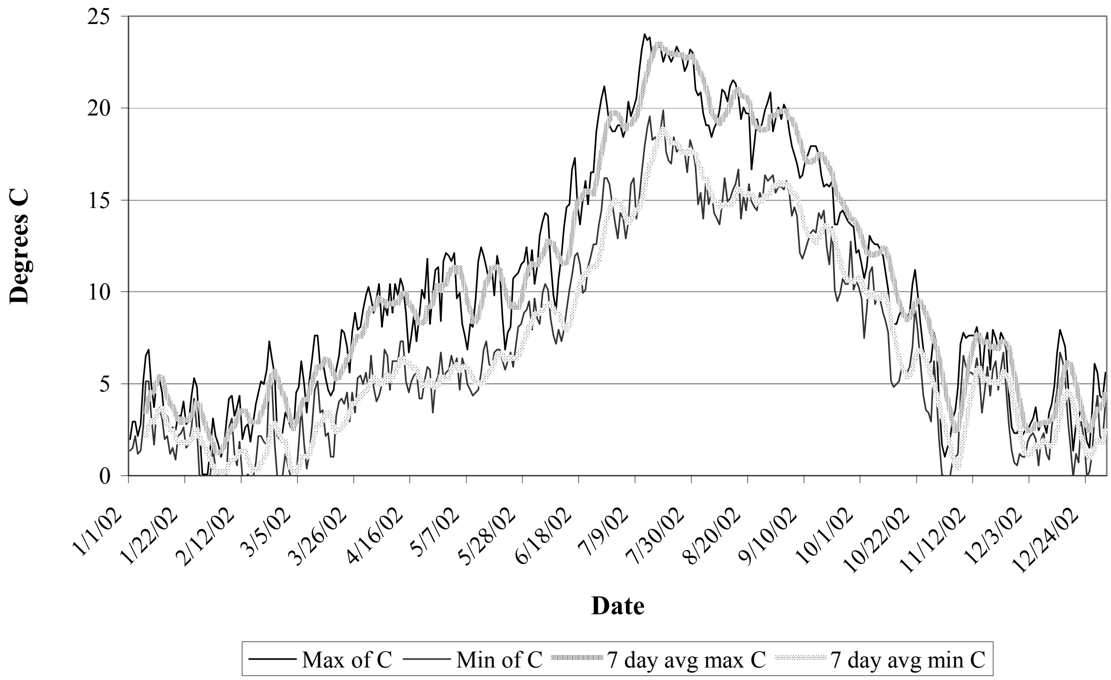
Lightning Creek water temperature 2000



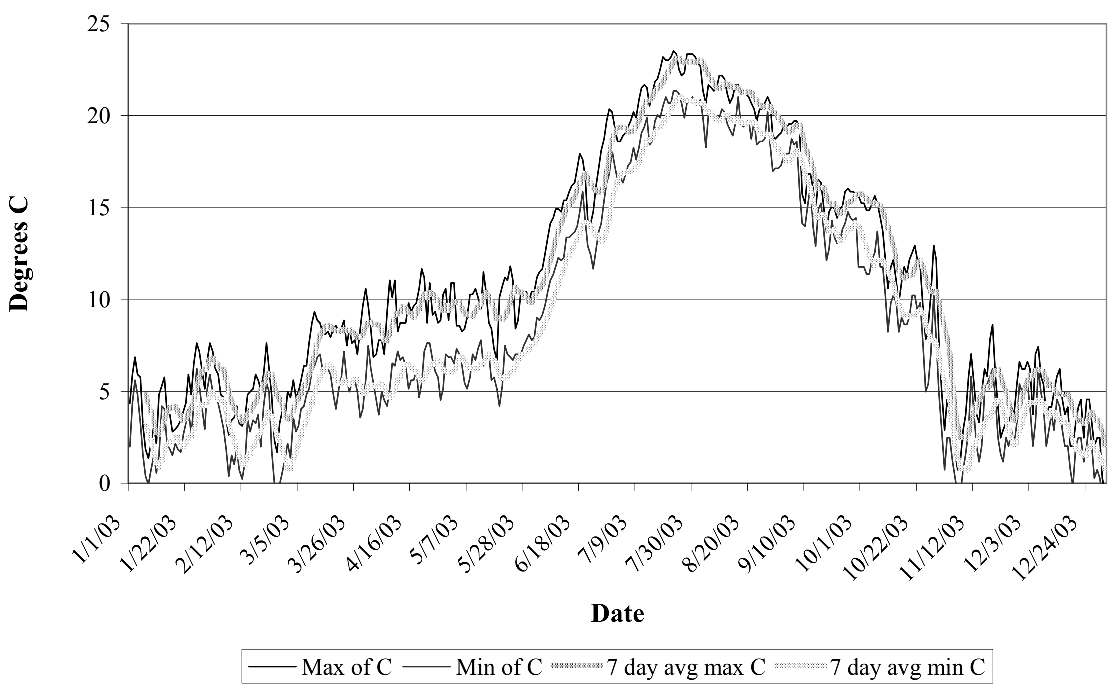
Lightning Creek water temperature 2001



Lightning Creek water temperature 2002

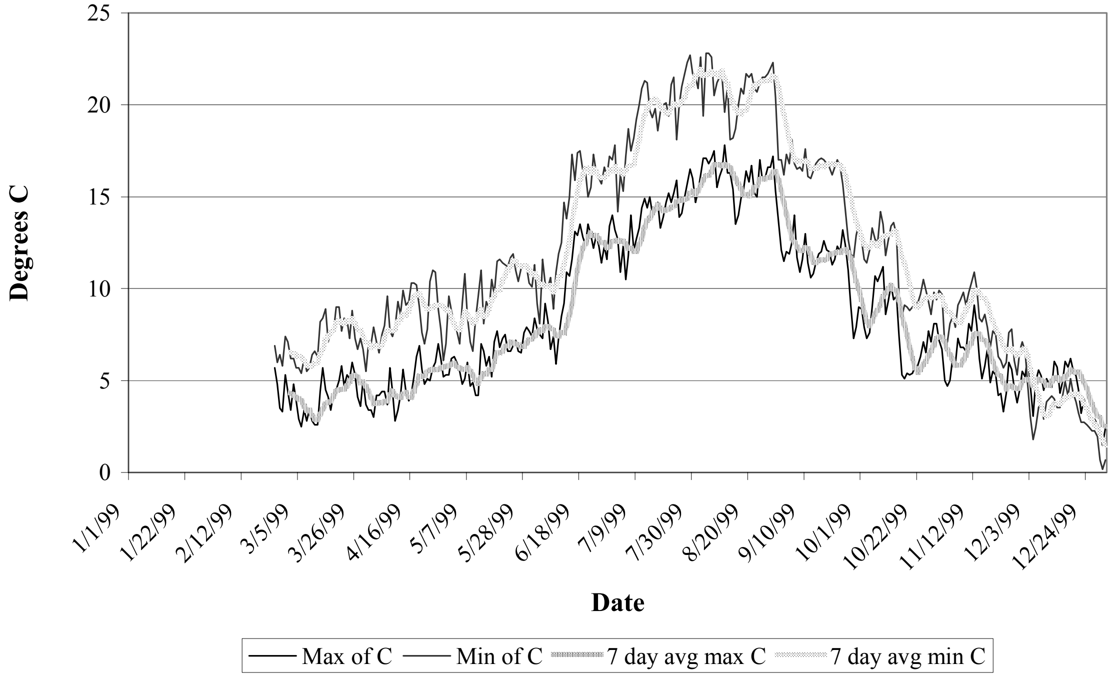


Lightning Creek water temperature 2003

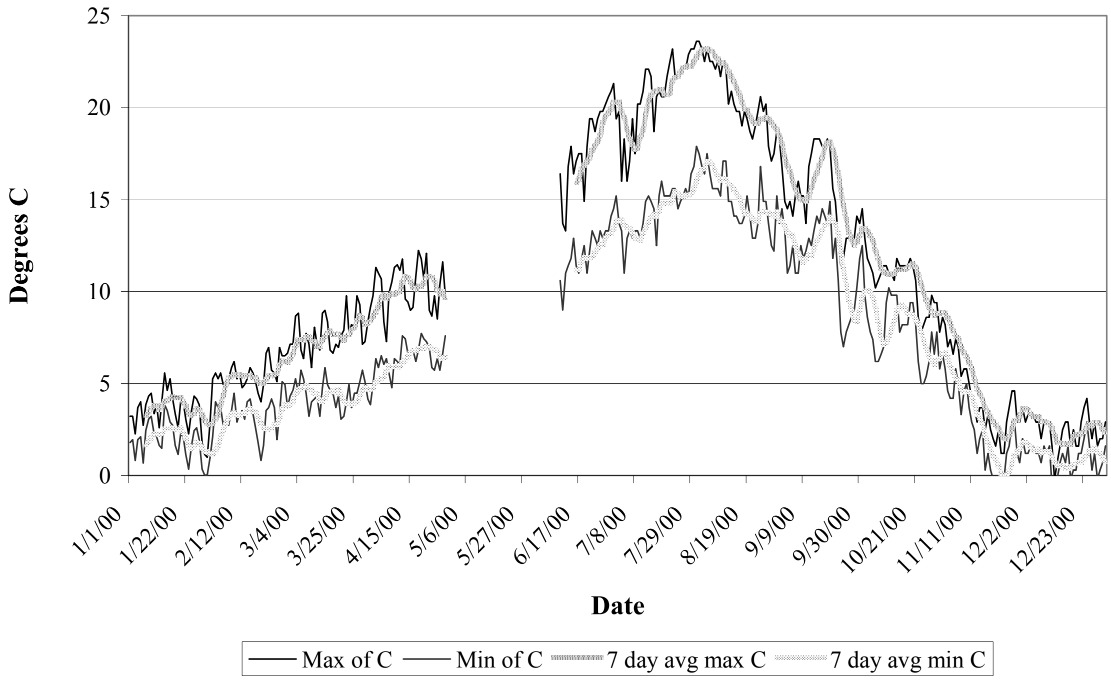


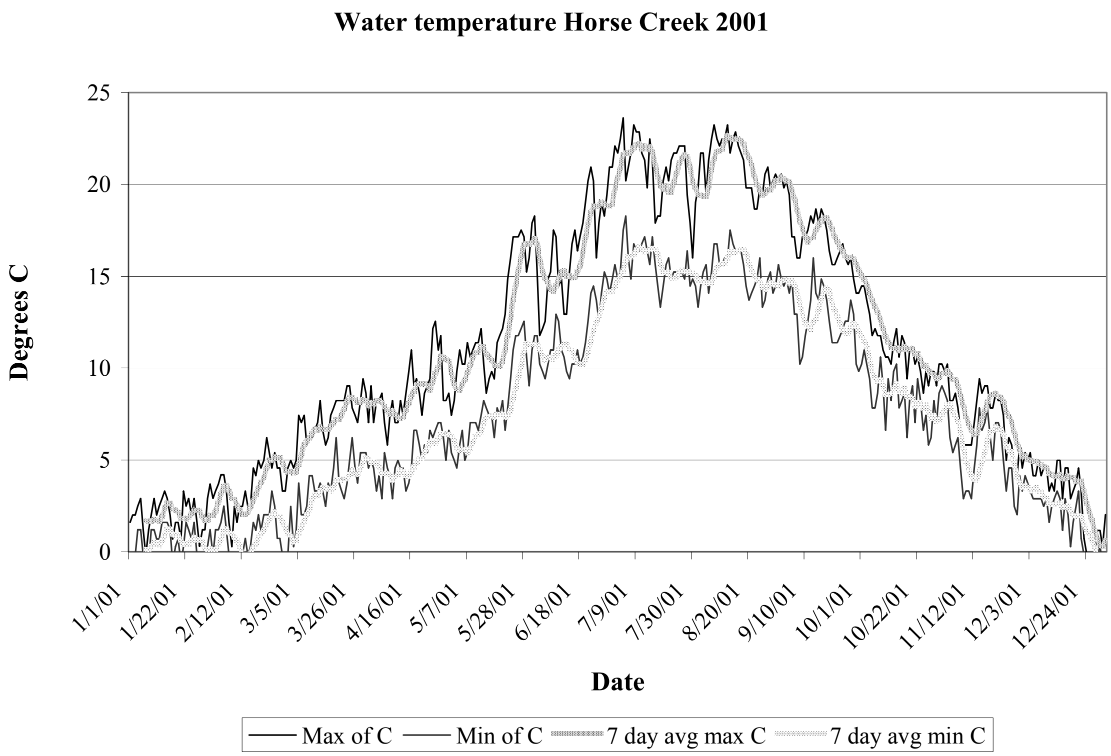
*2003 Lightning Creek temperature recorder was buried by bedload at the end of May and wasn't dug out till September. Maximum and minimum daily temperatures are not as variable as normal.

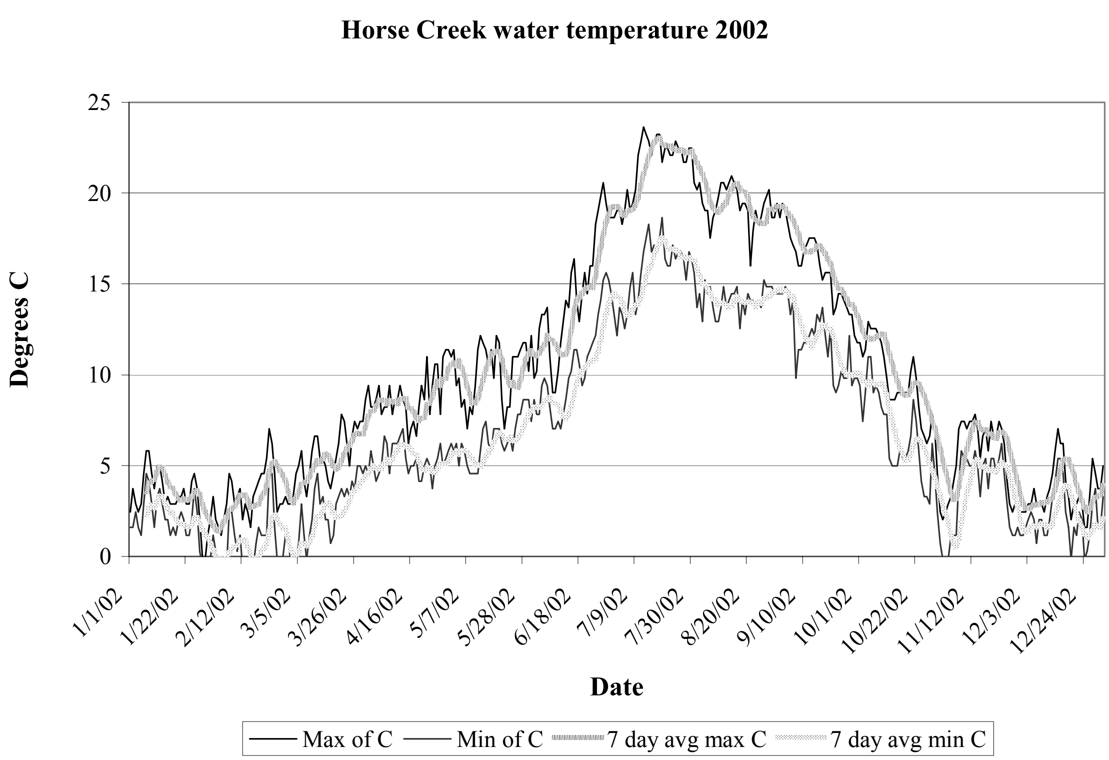
Horse Creek water temperature 1999



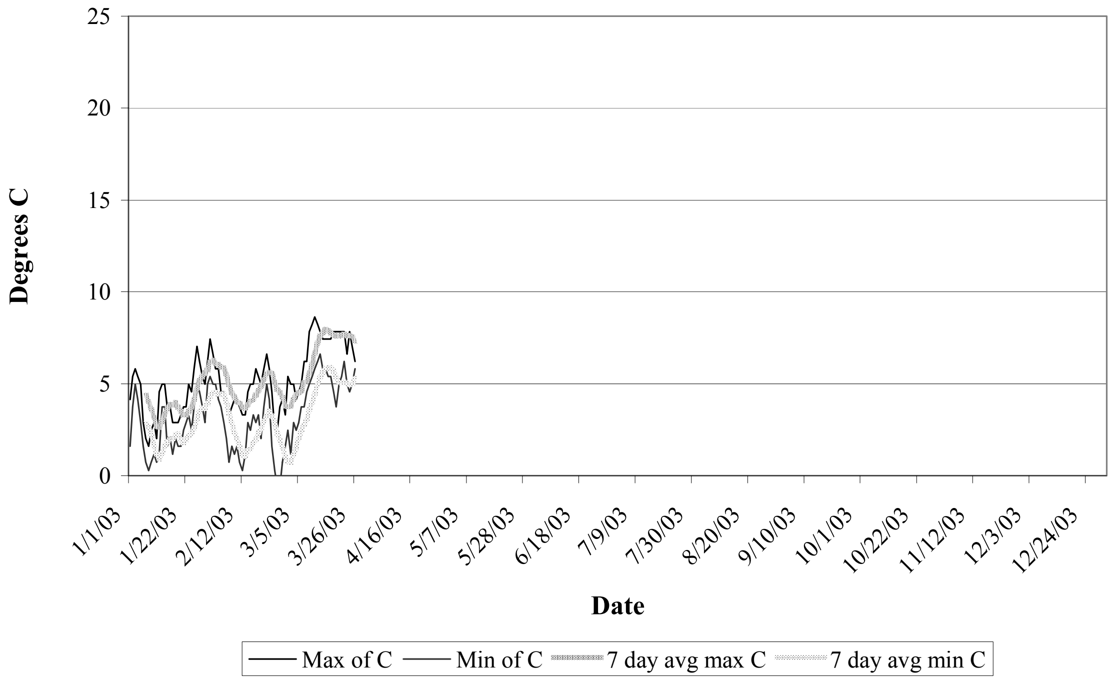
Horse Creek water temperature 2000




Water temperature Horse Creek 2001
25
20
15
10
5
0
Degrees C
1/1/01
1/22/01
2/12/01
3/5/01
3/26/01
4/16/01
5/7/01
5/28/01
6/18/01
7/9/01
7/30/01
8/20/01
9/10/01
10/1/01
10/22/01
11/12/01
12/3/01
12/24/01
Date
Max of C
Min of C
7 day avg max C
7 day avg min C

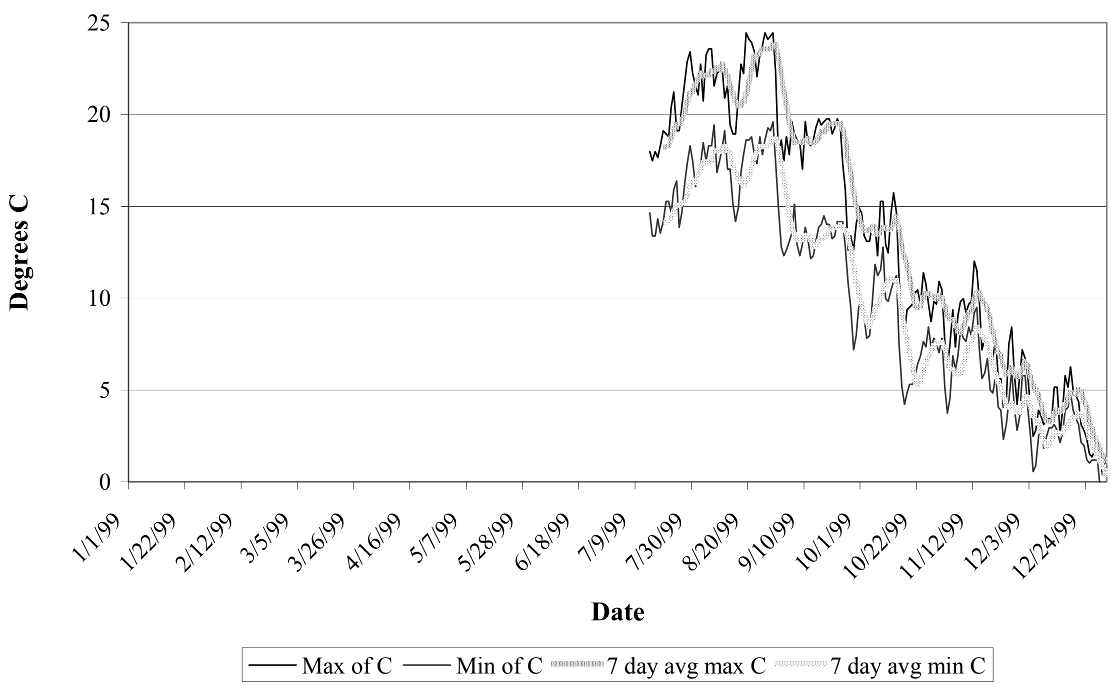

Horse Creek water temperature 2002
25
20
15
10
5
0
Degrees C
1/1/02
1/22/02
2/12/02
3/5/02
3/26/02
4/16/02
5/7/02
5/28/02
6/18/02
7/9/02
7/30/02
8/20/02
9/10/02
10/1/02
10/22/02
11/12/02
12/3/02
12/24/02
Date
Max of C
Min of C
7 day avg max C
7 day avg min C

Horse Creek water temperature 2003

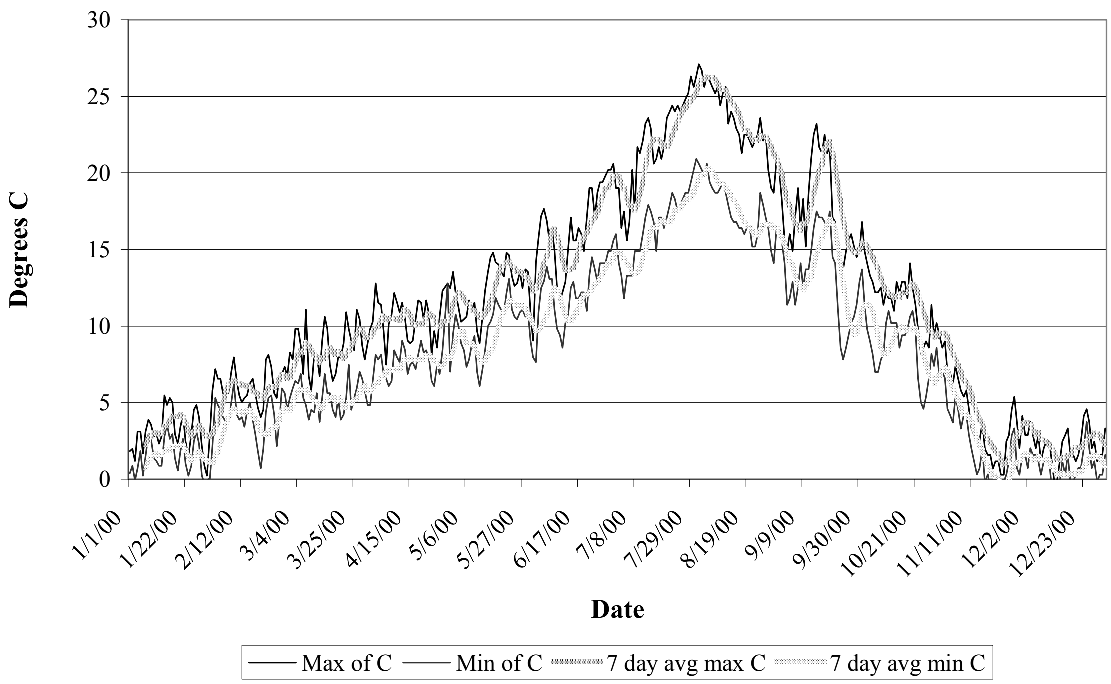


*During 2003, the Nez Perce Tribe was not allowed access to Horse Creek by landowner and had to pull temperature recorder.

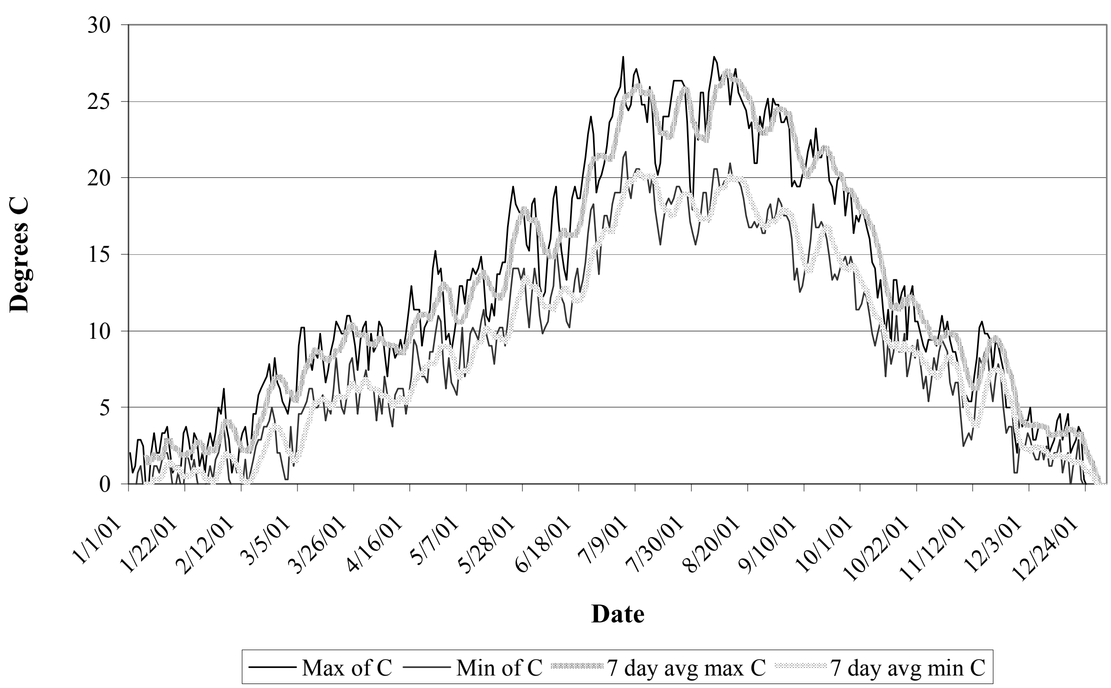
1999 Imnaha River water temperature at rkm 7



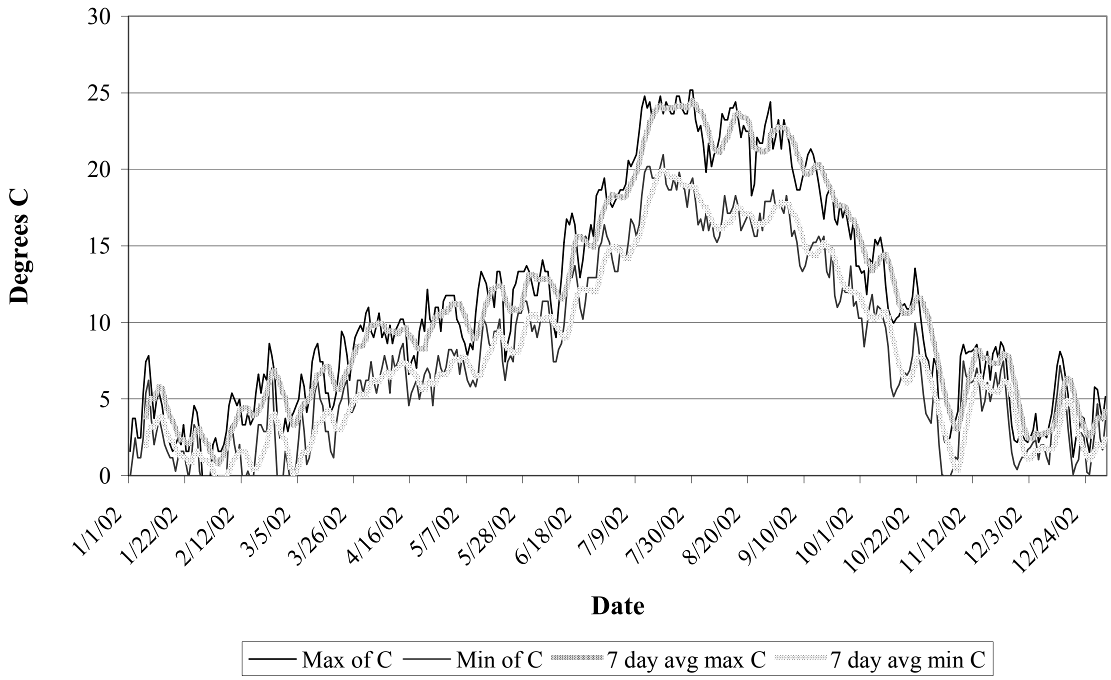
2000 Imnaha River water temperature at rkm 7



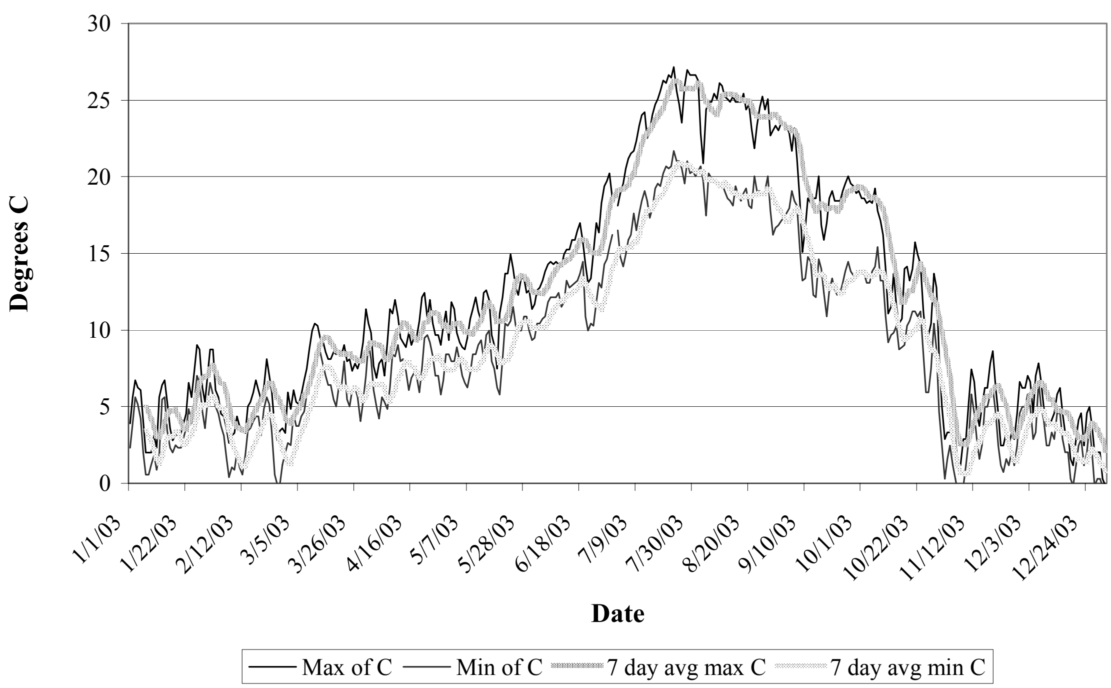
2001 Imnaha River water temperature at rkm 7



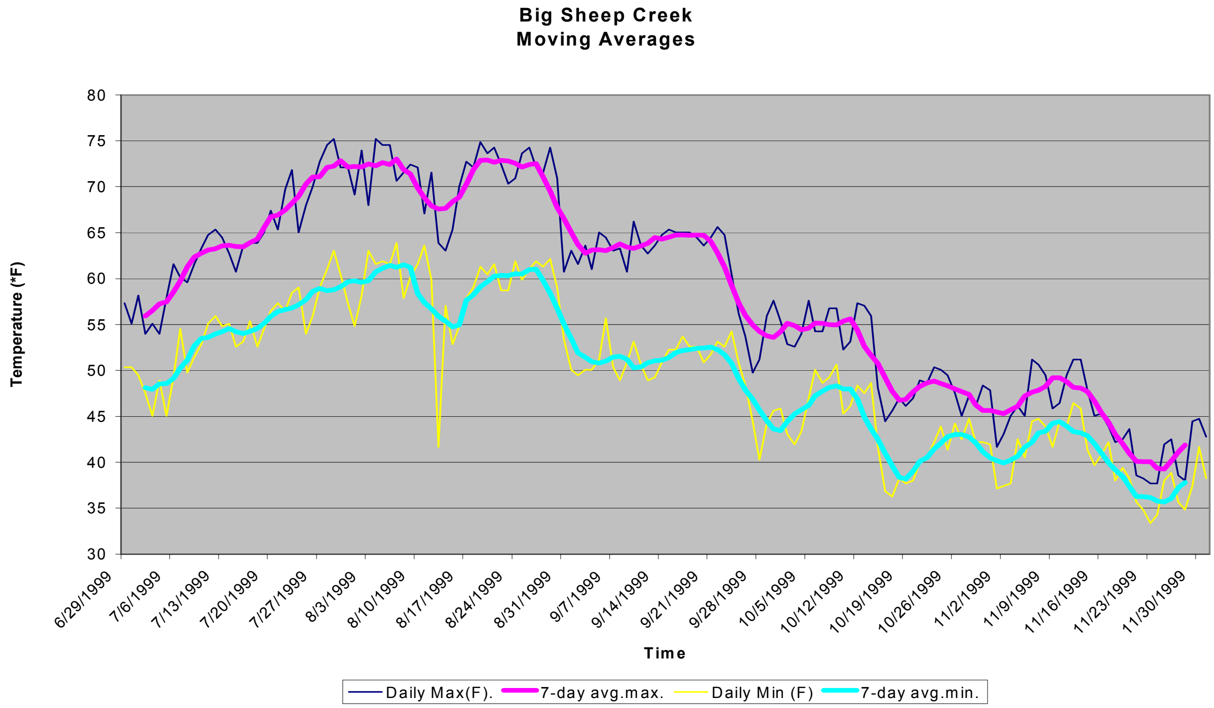
2002 Imanaha River water temperature at rkm 7

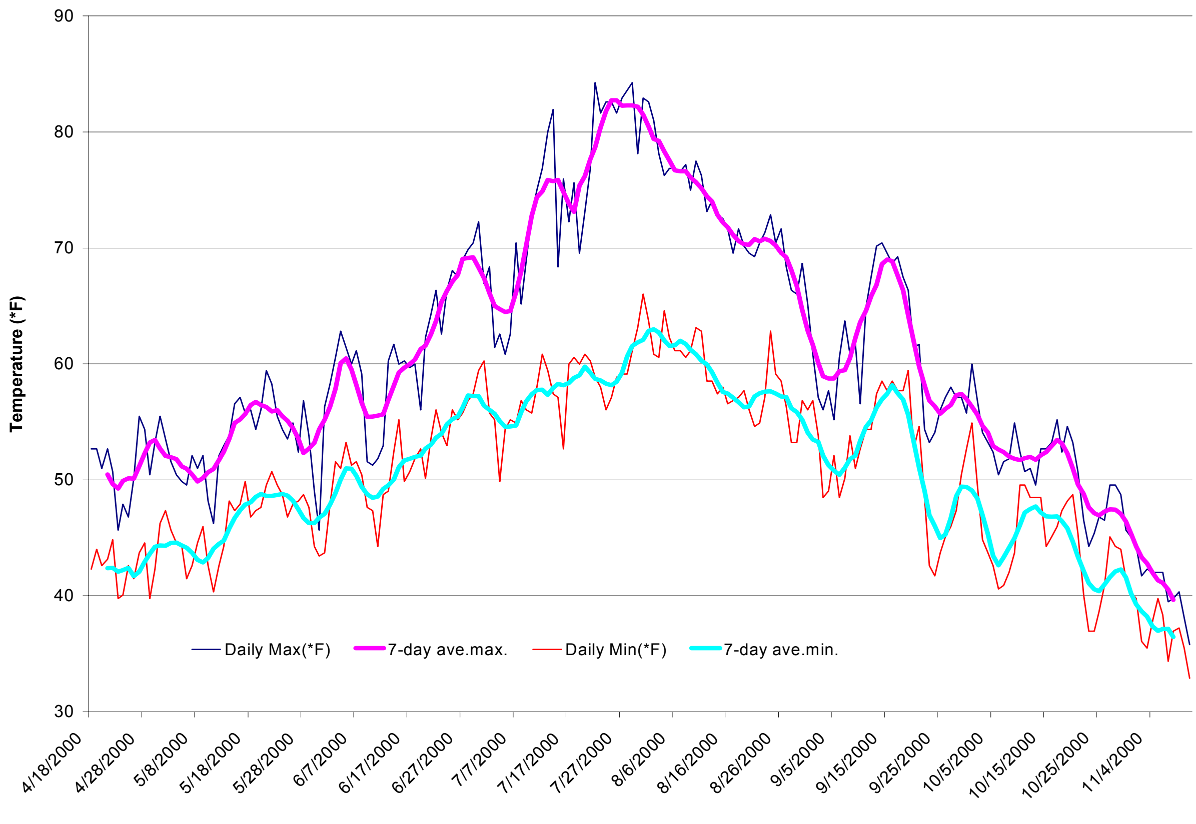


2003 Imnaha River water temperature at rkm 7

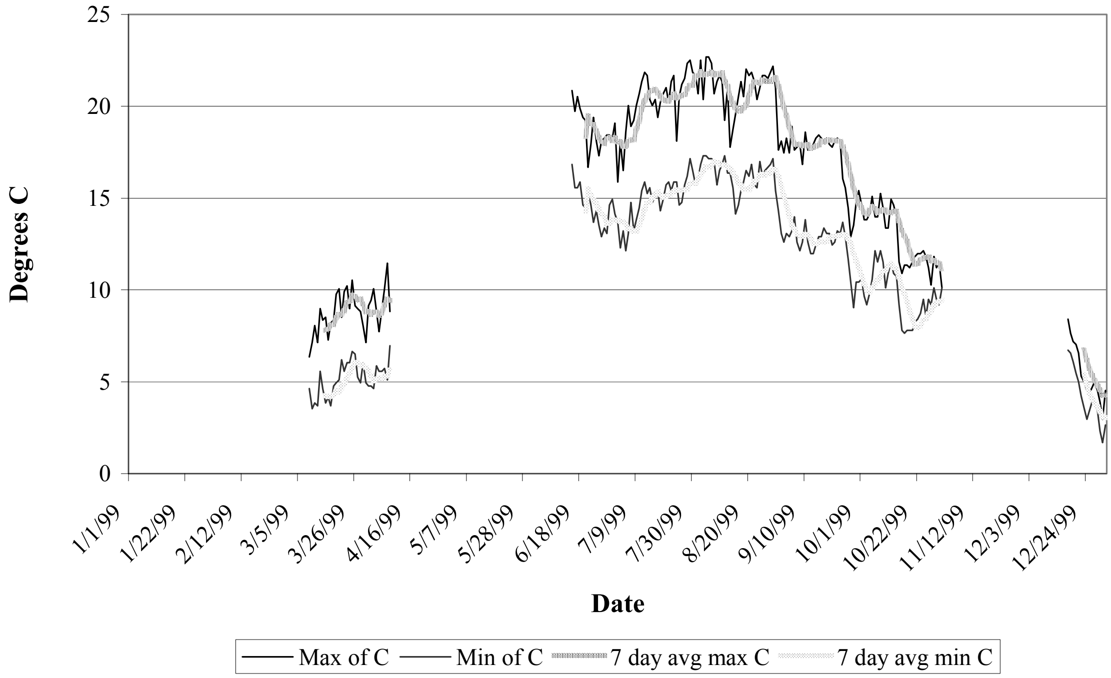


Big Sheep Creek Watershed, Water Temperatures:

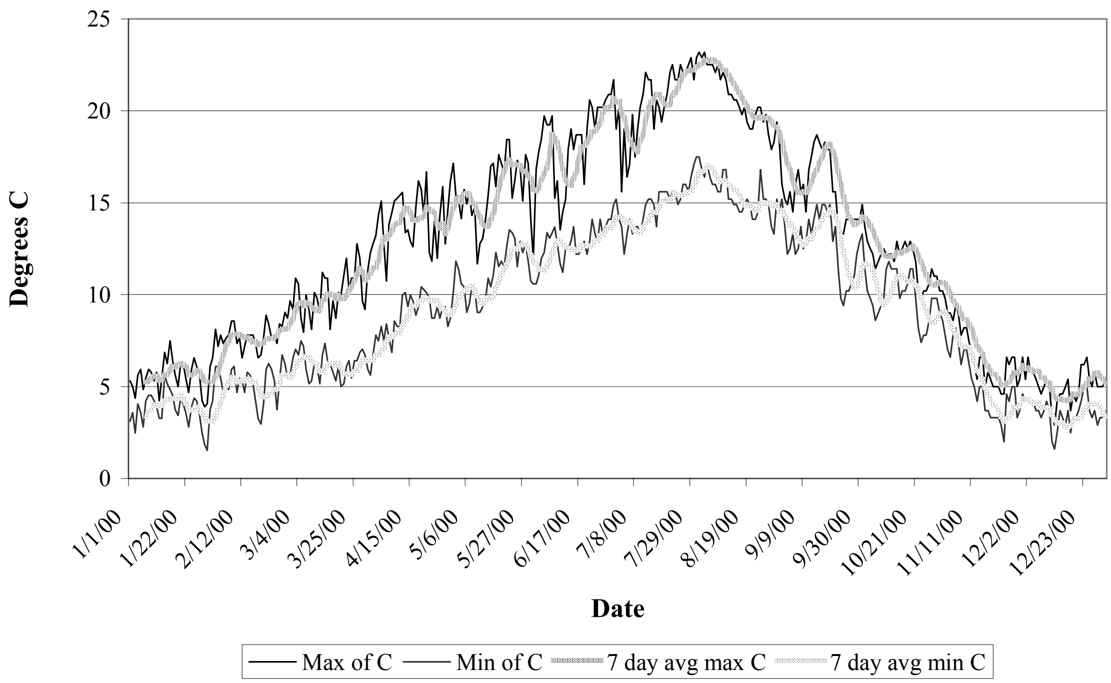




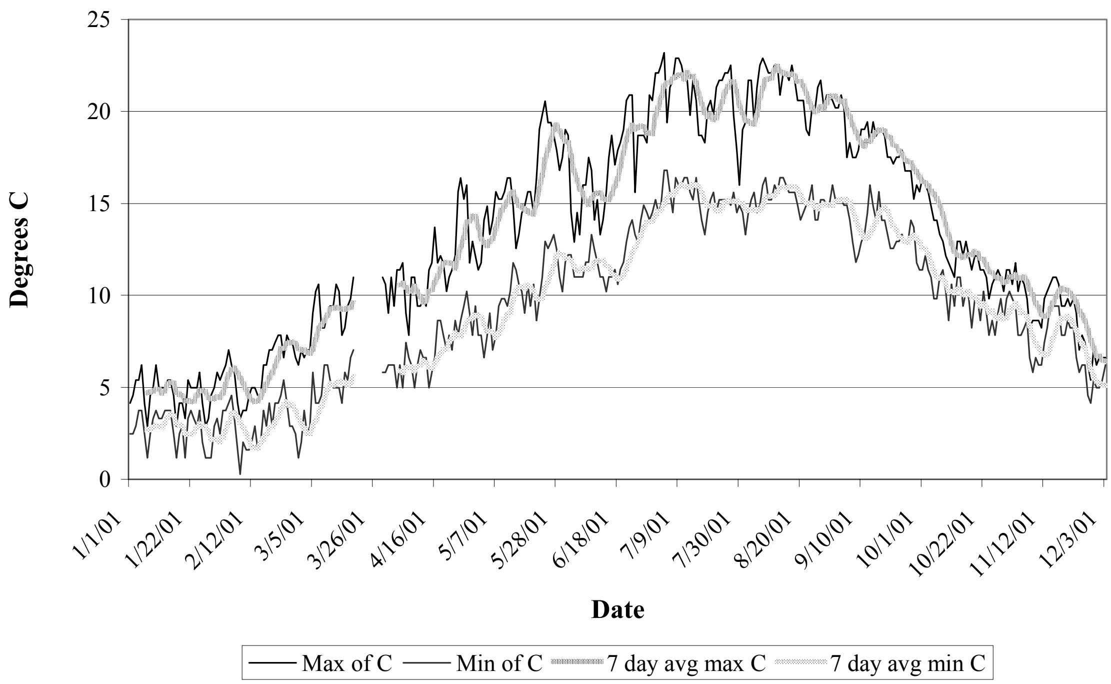
Camp Creek water temperature 1999



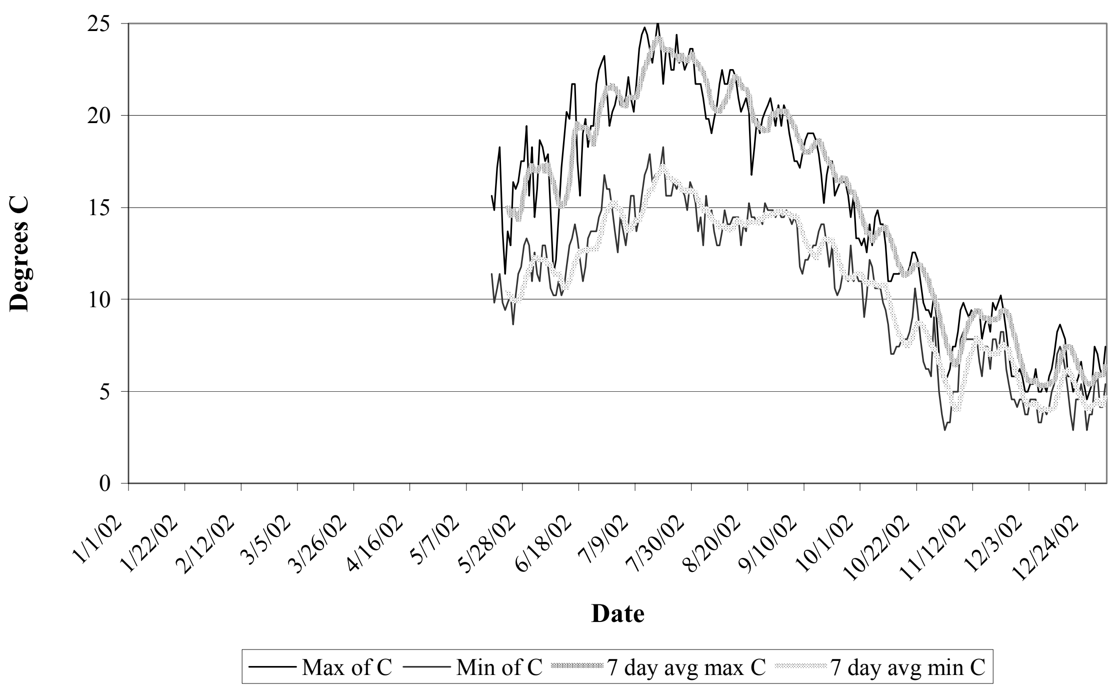
Camp Creek water temperature 2000



Camp Creek water temperature 2001

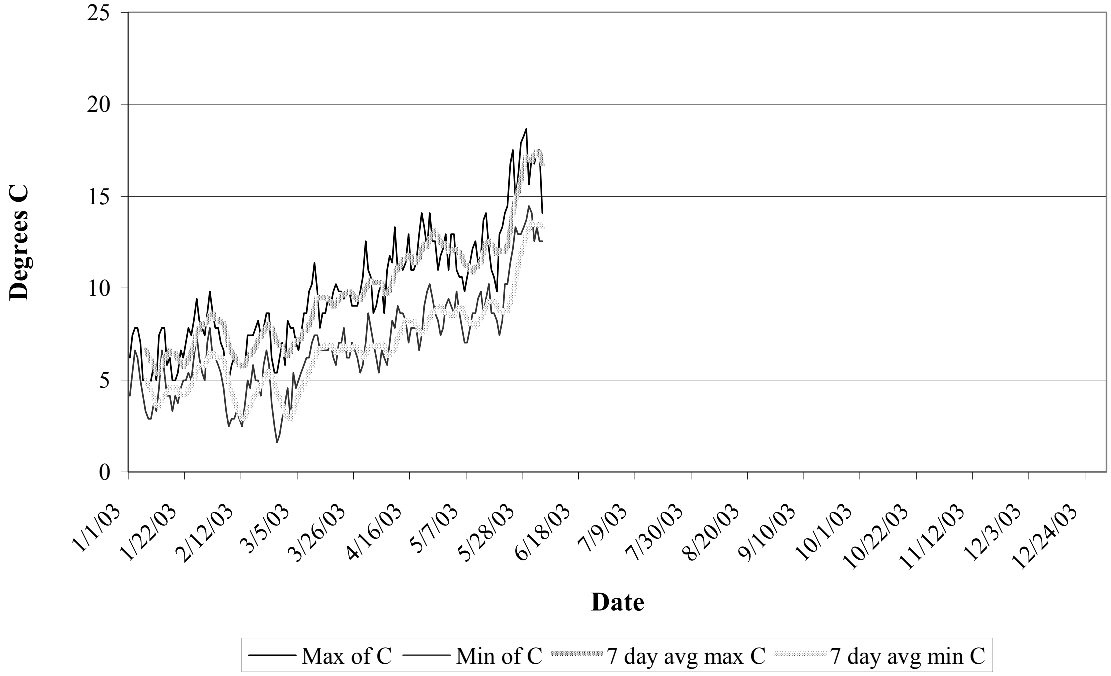


Camp Creek water temperature 2002

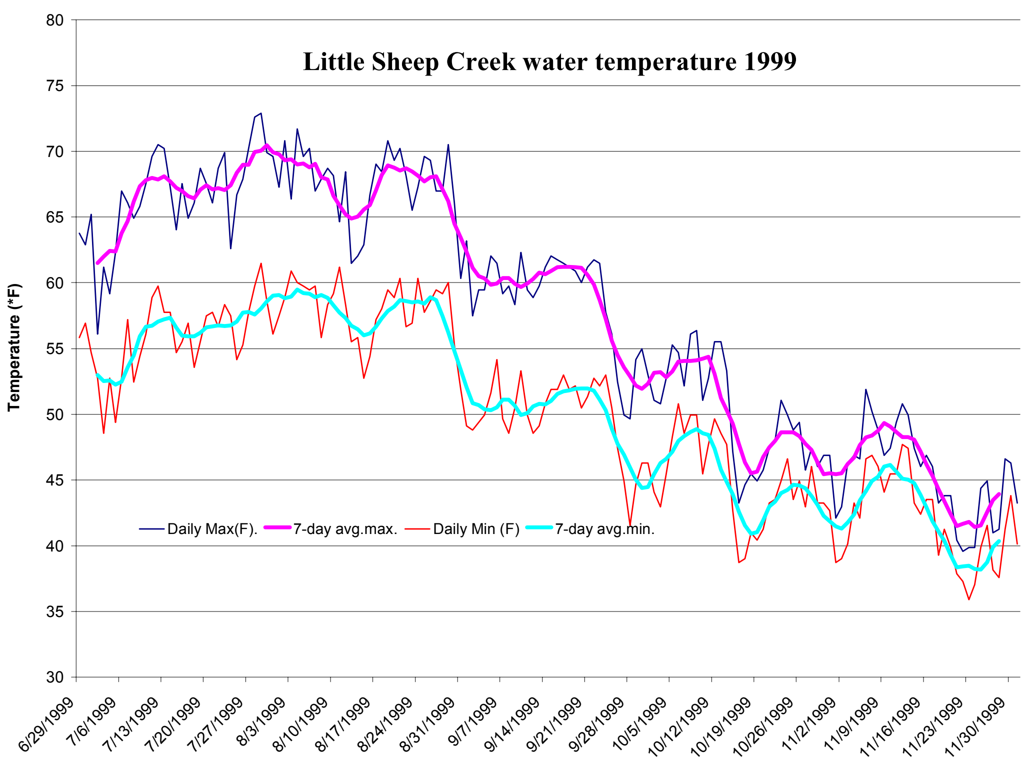


2002 Camp Creek temperature recorder was thrown out of water by some individual in early part of the year.

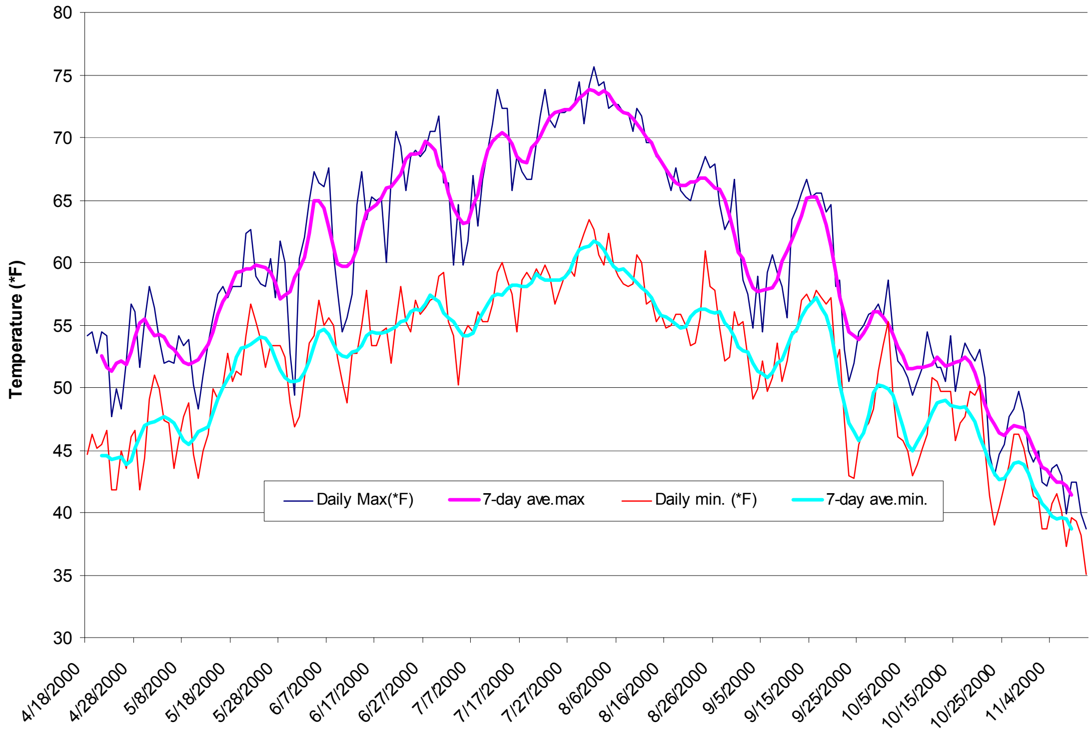
Camp Creek water temperature 2003



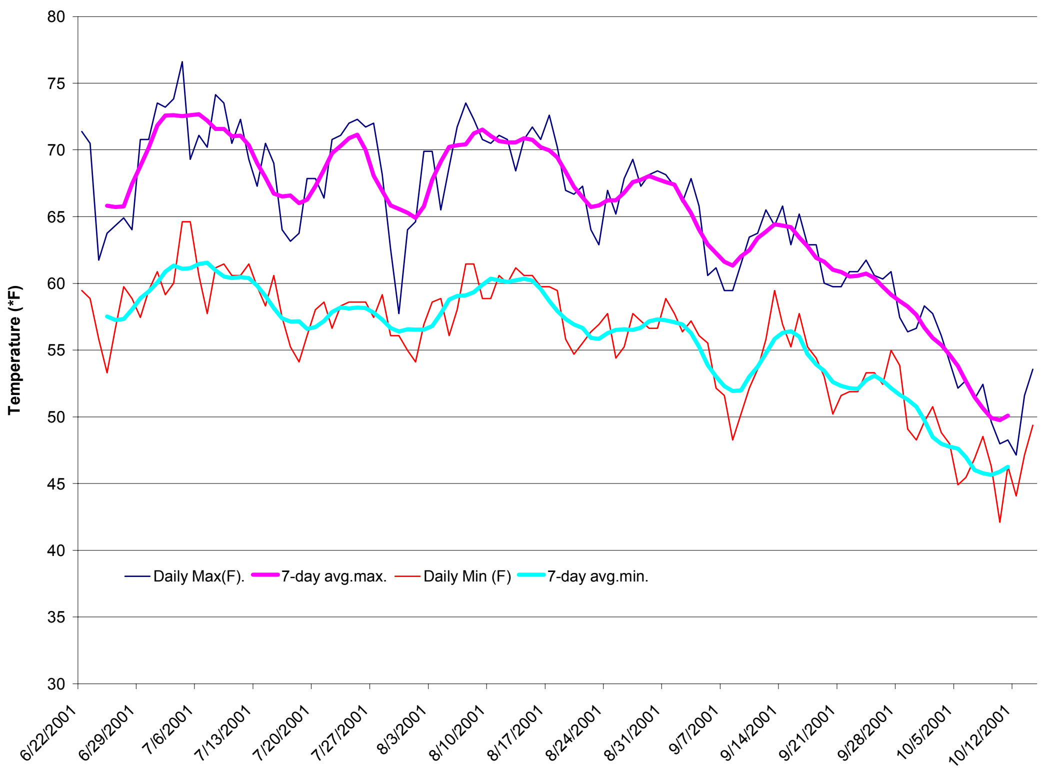
2003 Camp Creek temperature data for last half of year has yet to be downloaded from instrument.



Little Sheep Creek water temperature 2000

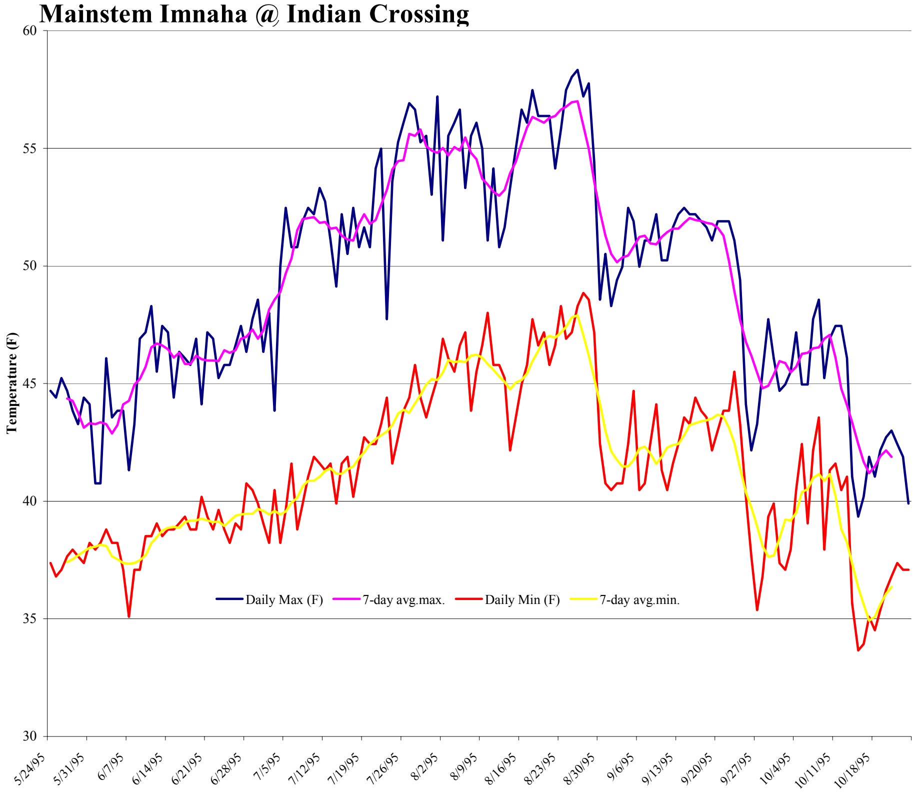


Little Sheep Creek water temperature 2001

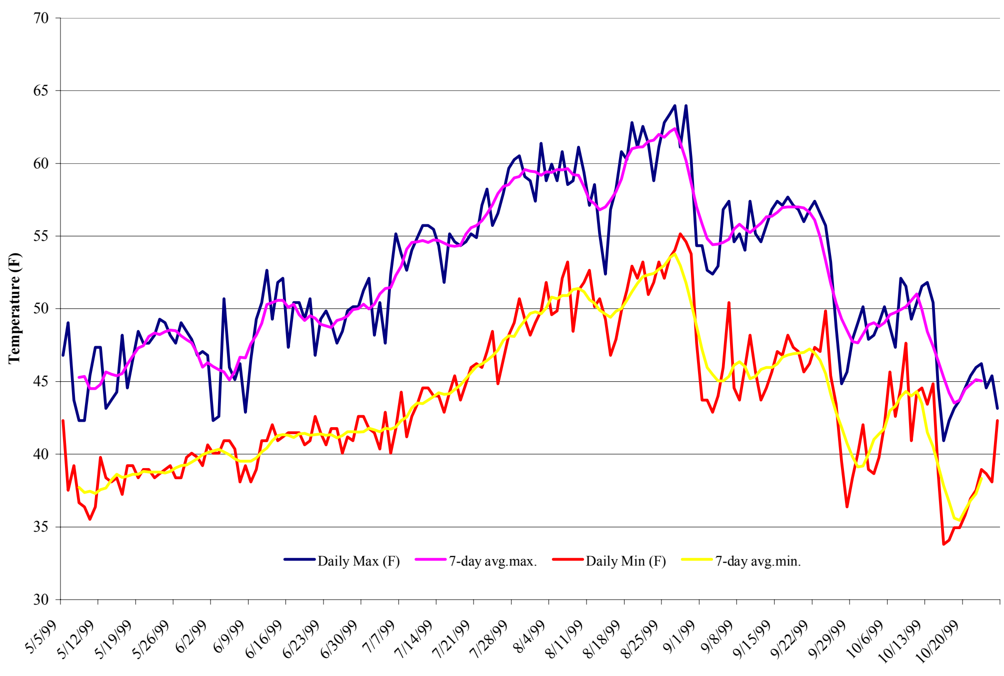


Upper Imnaha Watershed, Water Temperatures:

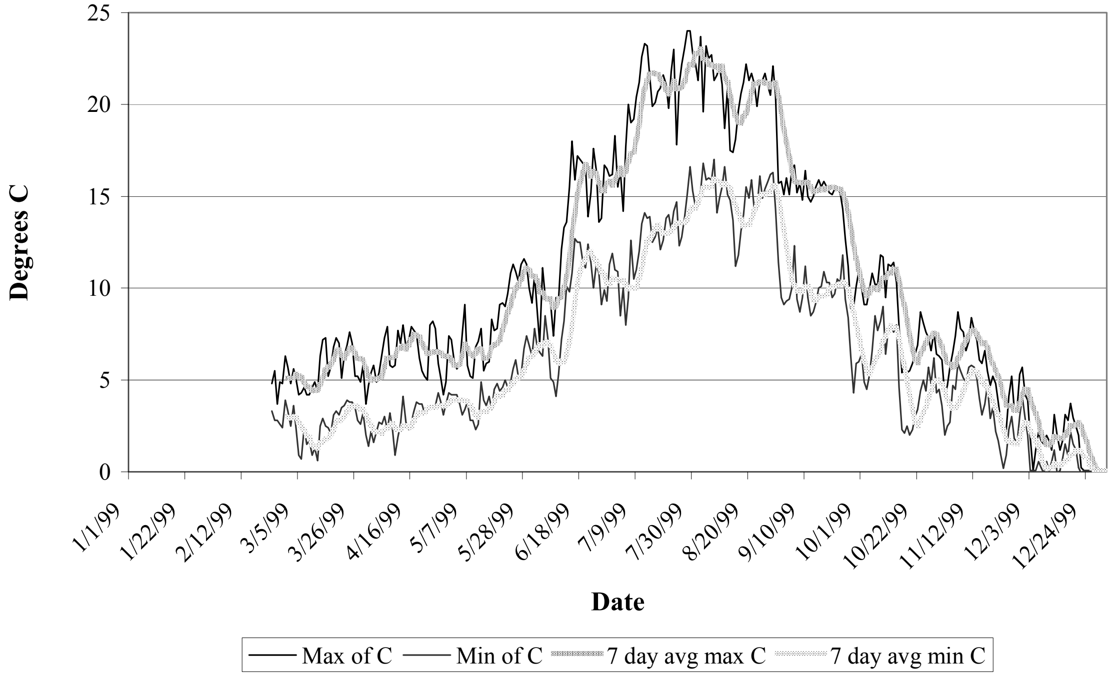
Mainstem Imnaha @ Indian Crossing



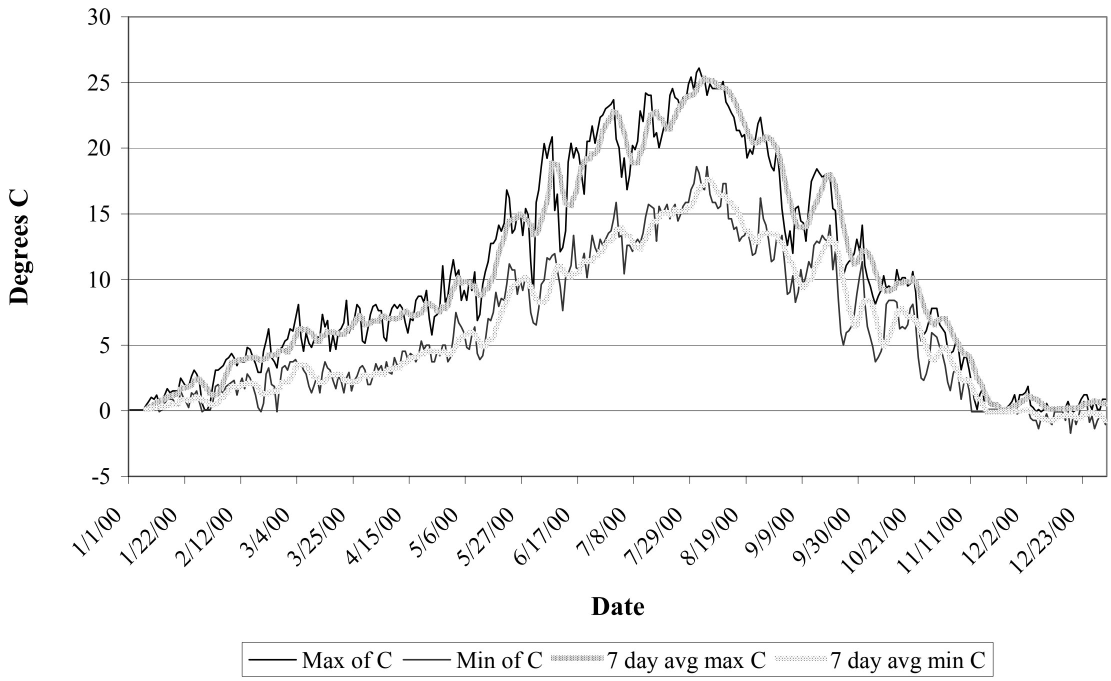
Mainstem Imnaha water temperatures (1999) @ Nine Points Creek



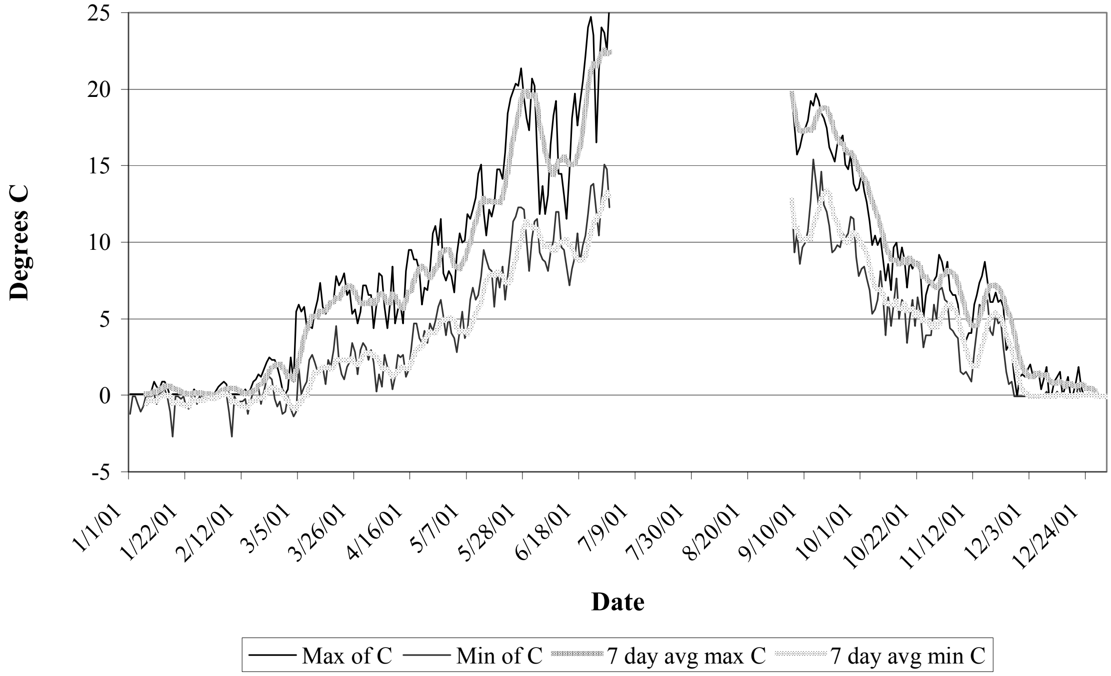
Grouse Creek water temperature 1999



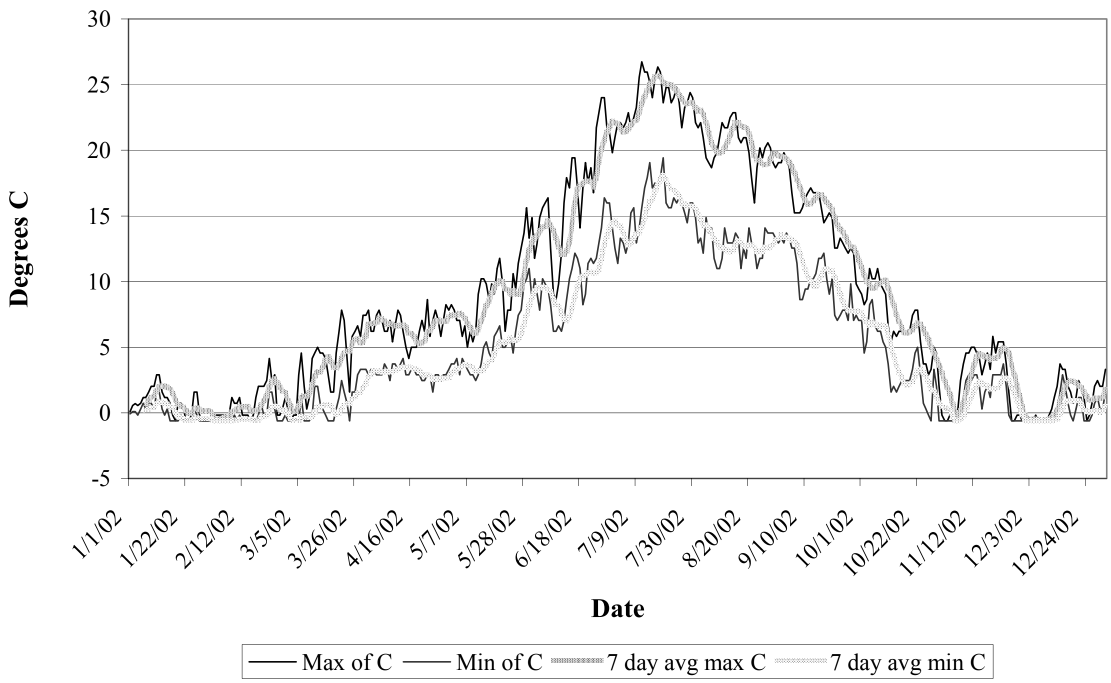
Grouse Creek water temperature 2000



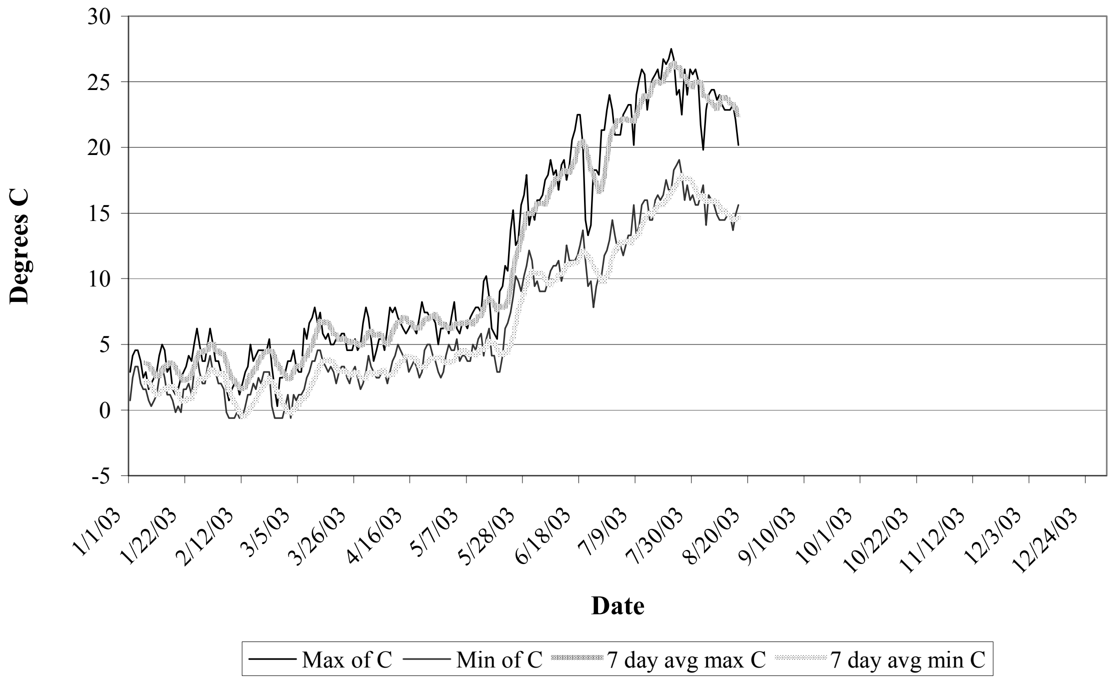
Grouse Creek water temperature 2001



Grouse Creek water temperature 2002

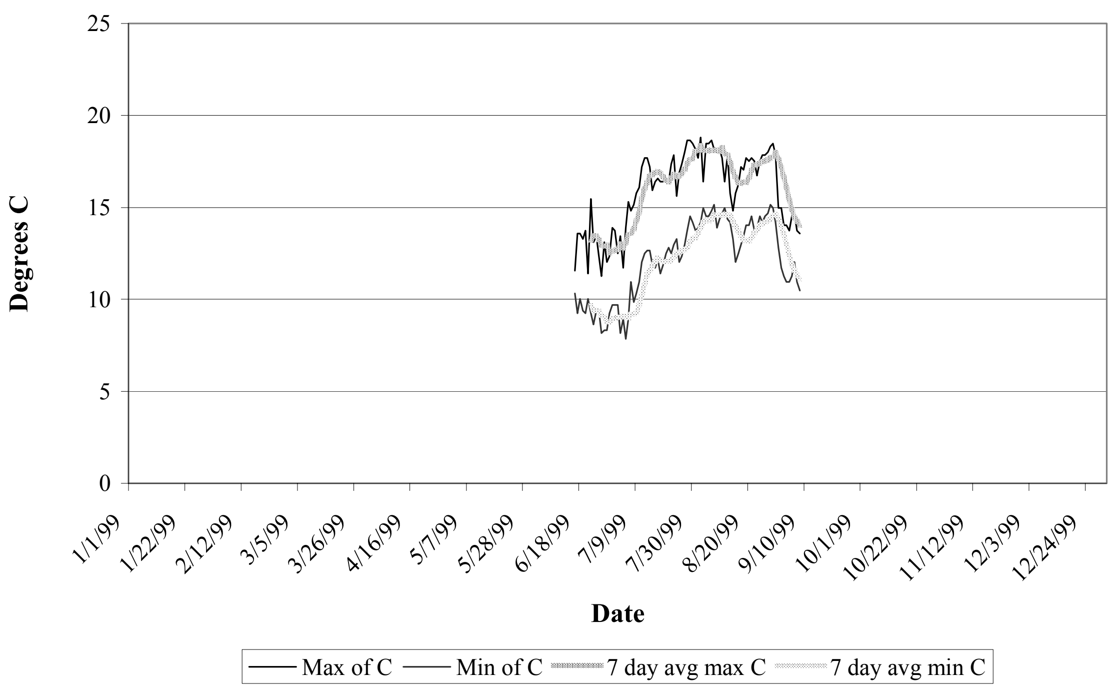


Grouse Creek water temperature 2003

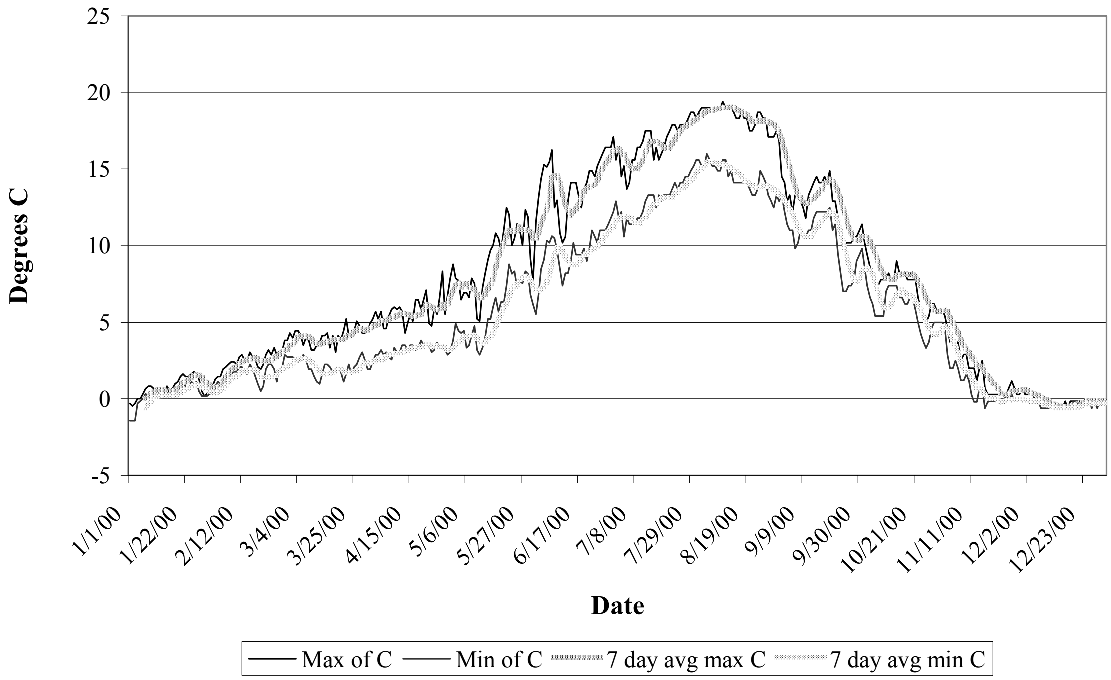


2003 Grouse Creek temperature data for last half of year has yet to be downloaded from instrument.

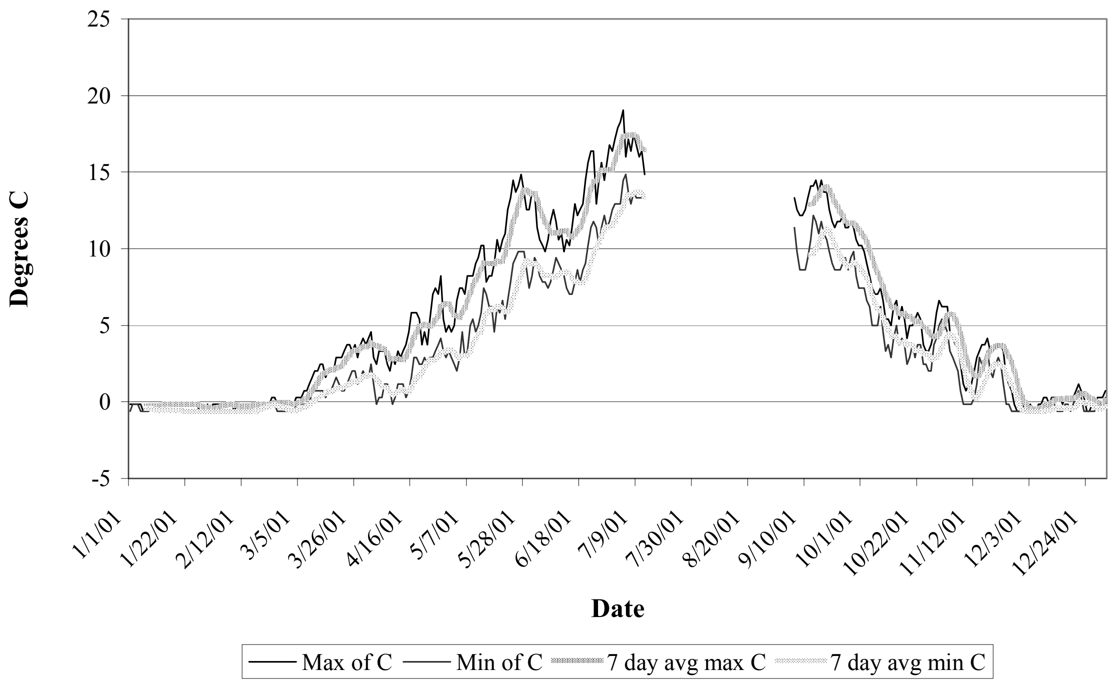
Gumboot Creek water temperature 1999



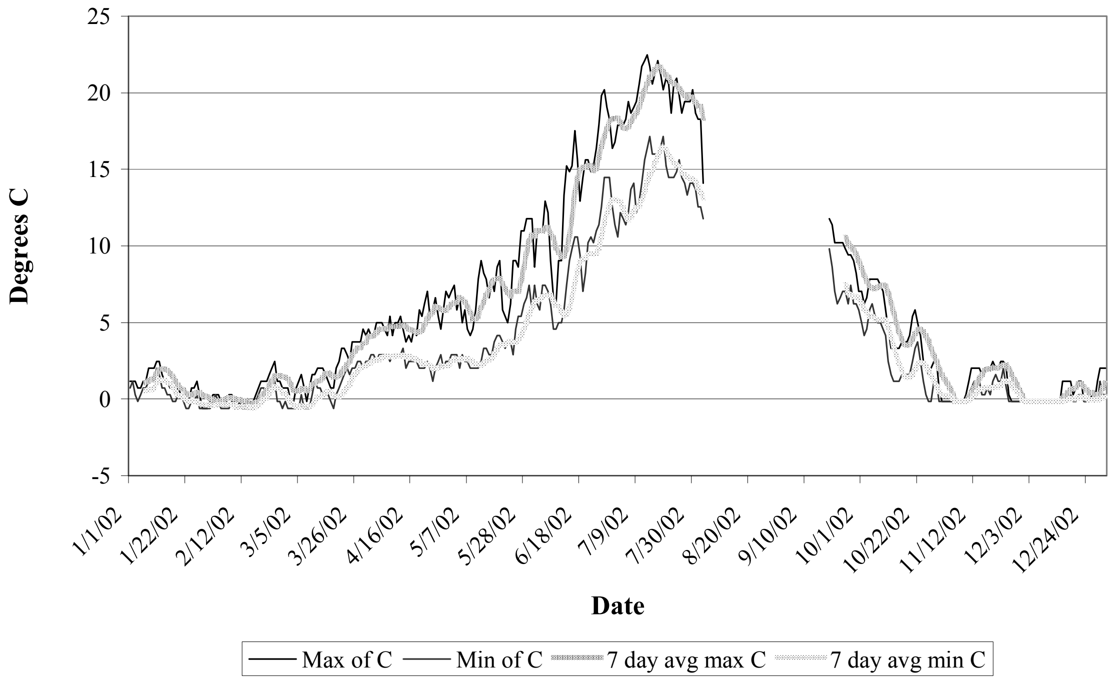
Gumboot Creek water temperature 2000



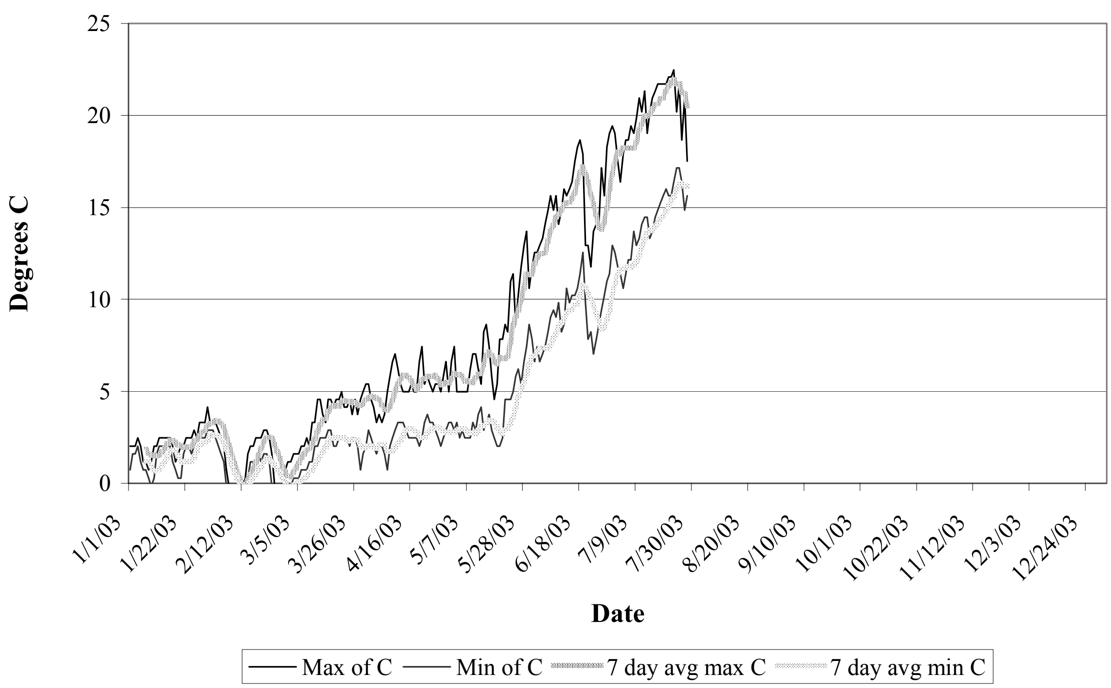
Gumboot Creek water temperature 2001



Gumboot Creek water temperature 2002

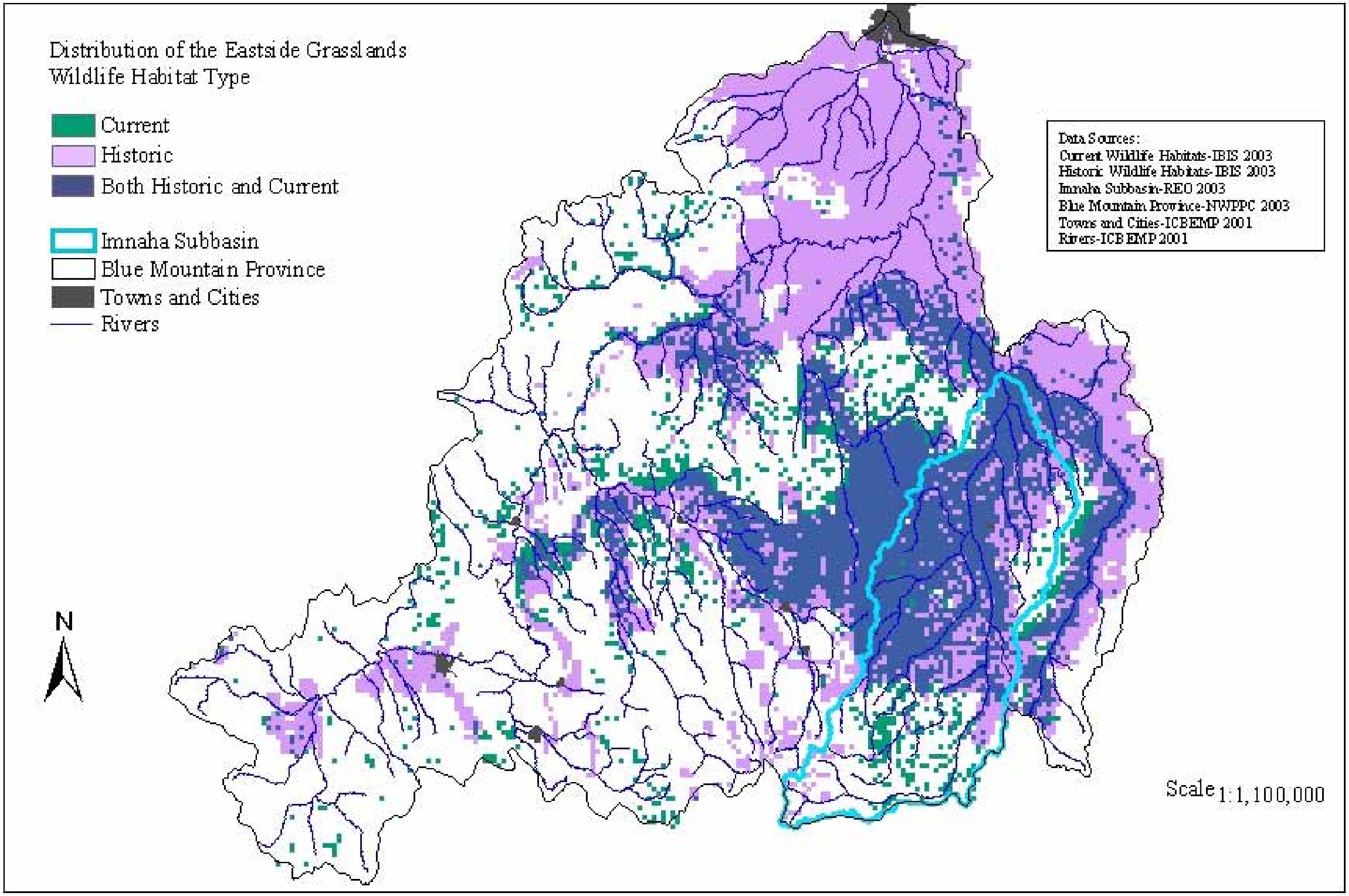


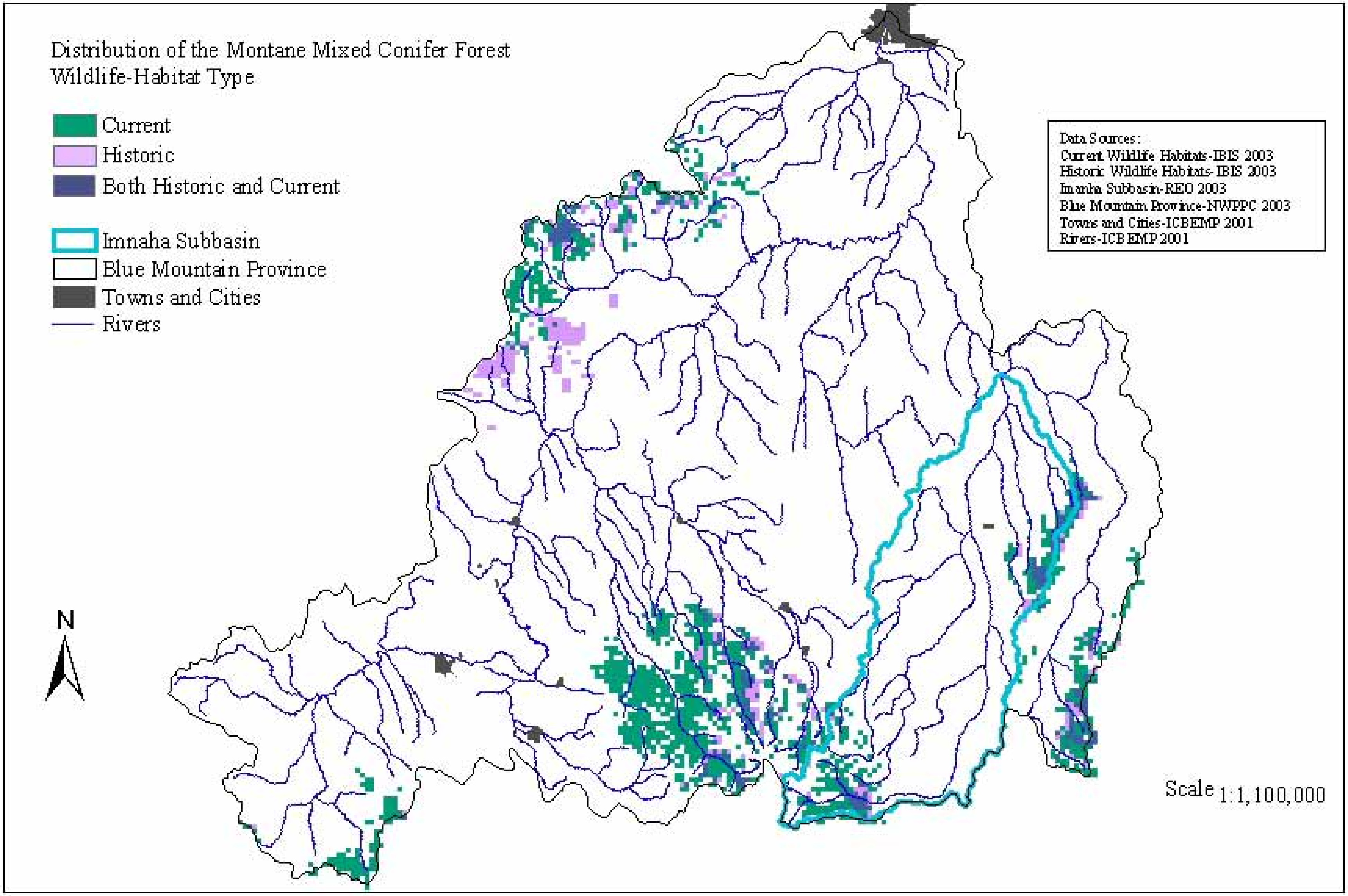
Gumboot Creek water temperature 2003

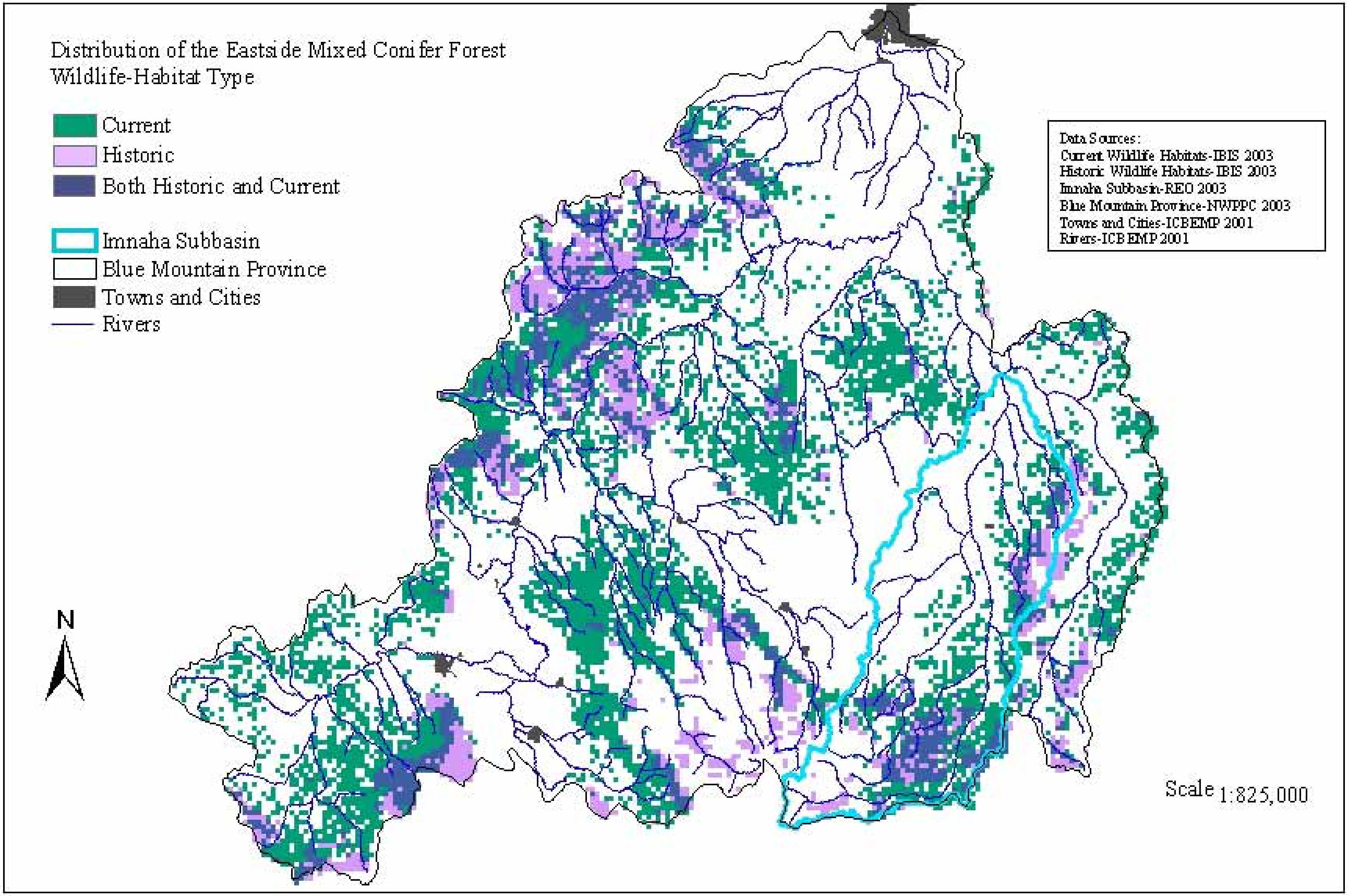


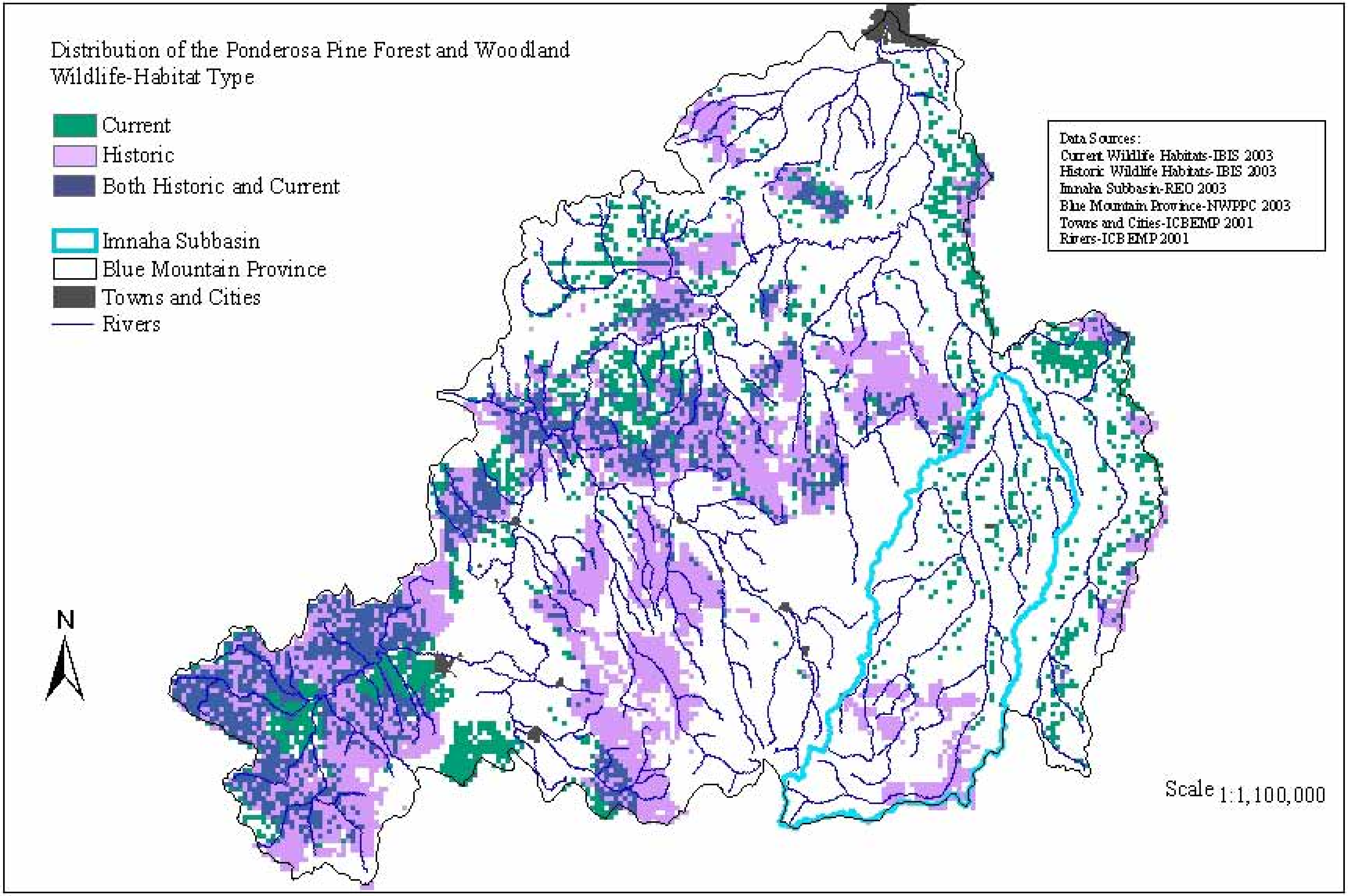
*2003 Gumboot Creek temperature data for last half of year has yet to be downloaded from instrument.

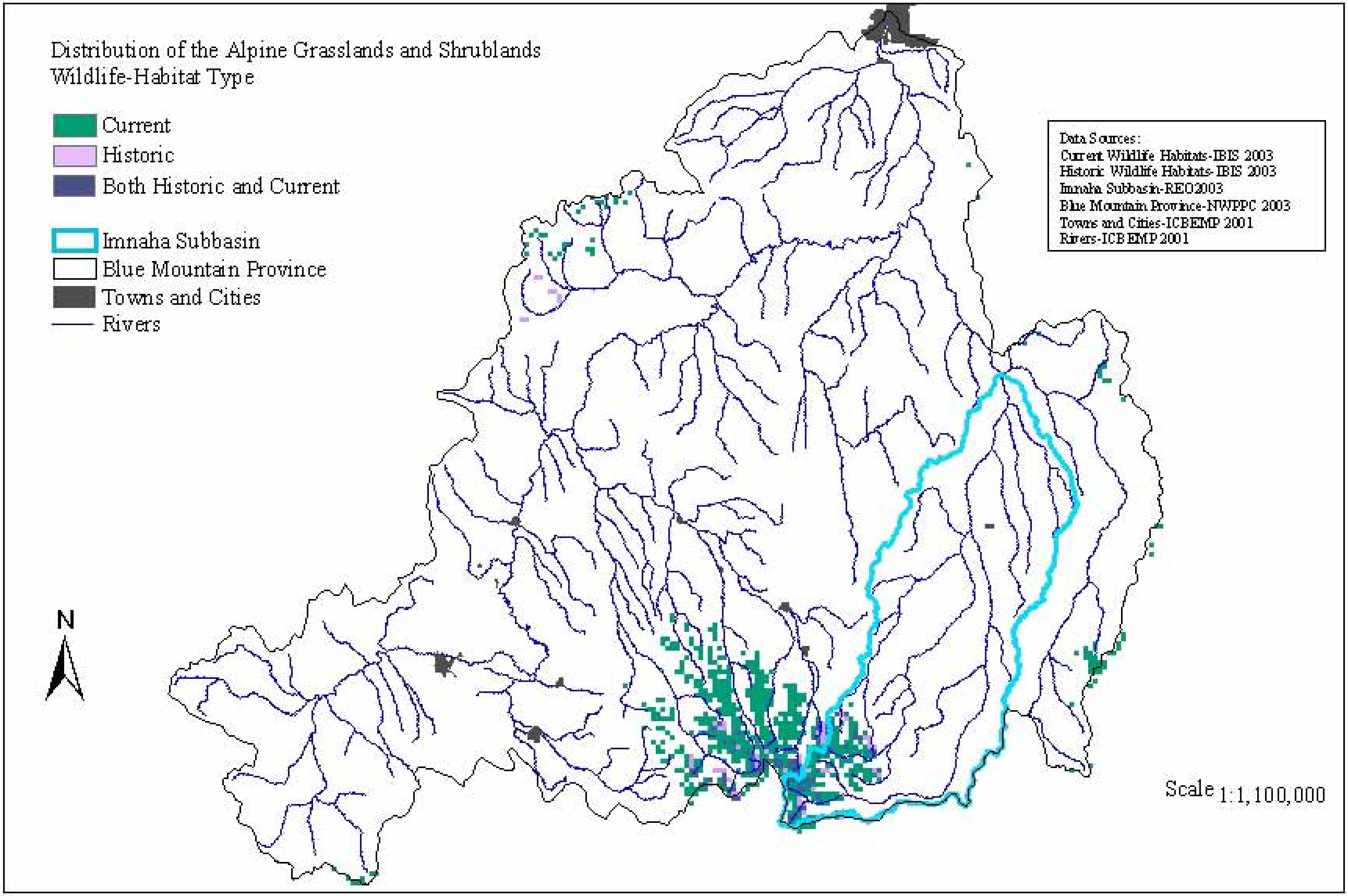
Appendix D. Comparison of the historical and current distributions for the major wildlife habitat types (WHTs) of the Imnaha subbasin and Blue Mountain Ecoprovince.

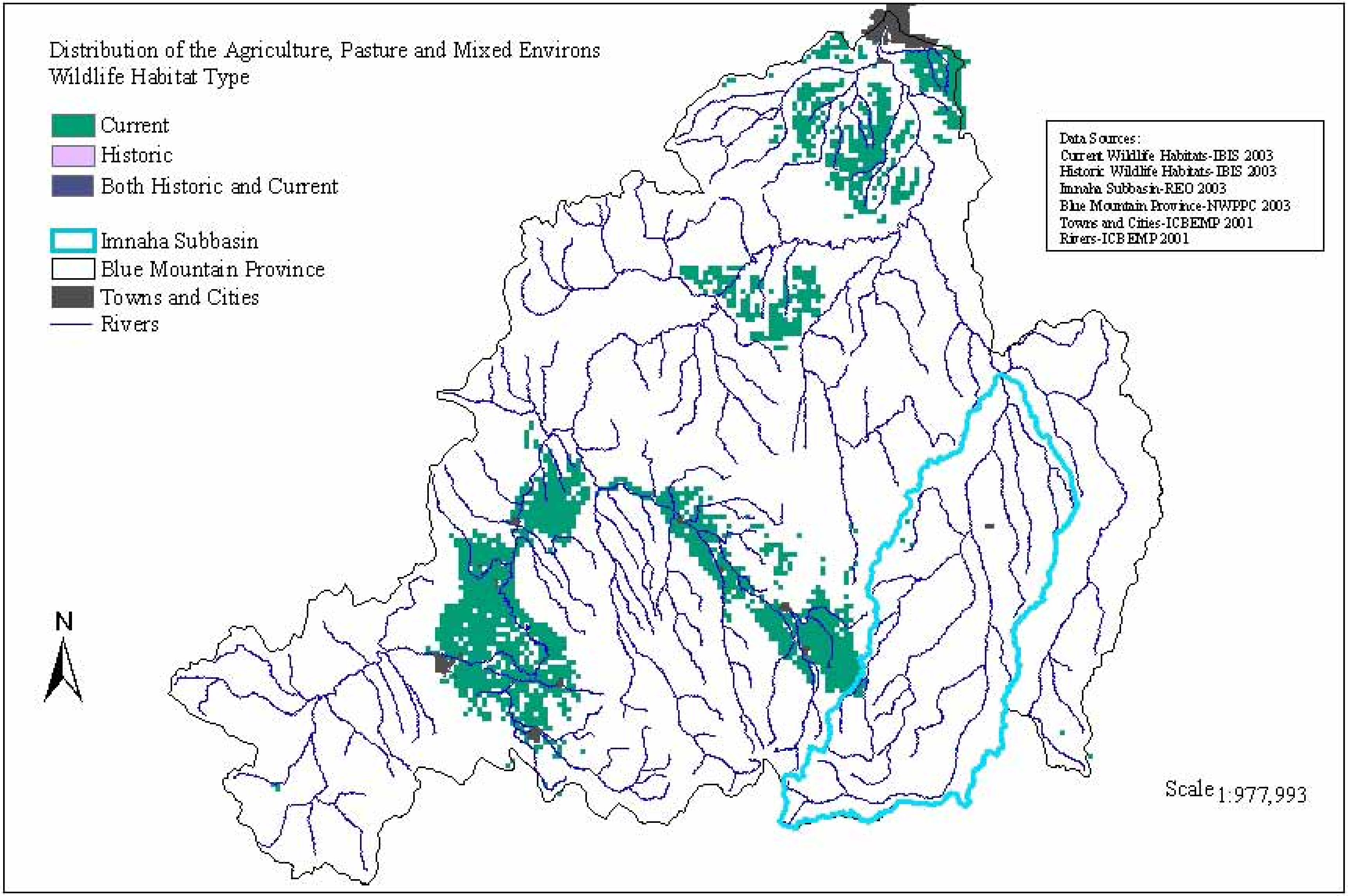



Distribution of the Montane Mixed Conifer Forest
Wildlife-Habitat Type
Current
Historic
Both Historic and Current
Imnaha Subbasin
Blue Mountain Province
Towns and Cities
Rivers
N
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Imnaha Subbasin-REO 2003
Blue Mountain Province-NWPPC 2003
Towns and Cities-ICBEMP 2001
Rivers-ICBEMP 2001
Scale 1:1,100,000


Distribution of the Eastside Mixed Conifer Forest
Wildlife-Habitat Type
Current
Historic
Both Historic and Current
Imnaha Subbasin
Blue Mountain Province
Towns and Cities
Rivers
N
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Imnaha Subbasin-REO 2003
Blue Mountain Province-NWPPC 2003
Towns and Cities-ICBEMP 2001
Rivers-ICBEMP 2001
Scale 1:825,000


Distribution of the Ponderosa Pine Forest and Woodland
Wildlife-Habitat Type
Current
Historic
Both Historic and Current
Imnaha Subbasin
Blue Mountain Province
Towns and Cities
Rivers
N
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Imnaha Subbasin-REO 2003
Blue Mountain Province-NWPPC 2003
Towns and Cities-ICBEMP 2001
Rivers-ICBEMP 2001
Scale 1:1,100,000


Distribution of the Alpine Grasslands and Shrublands
Wildlife-Habitat Type
Current
Historic
Both Historic and Current
Imnaha Subbasin
Blue Mountain Province
Towns and Cities
Rivers
N
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Imnaha Subbasin-REO2003
Blue Mountain Province-NWPPC 2003
Towns and Cities-ICBEMP 2001
Rivers-ICBEMP 2001
Scale 1:1,100,000


Distribution of the Agriculture, Pasture and Mixed Environs
Wildlife Habitat Type
Current
Historic
Both Historic and Current
Imnaha Subbasin
Blue Mountain Province
Towns and Cities
Rivers
N
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Imnaha Subbasin-REO 2003
Blue Mountain Province-NWPPC 2003
Towns and Cities-ICBEMP 2001
Rivers-ICBEMP 2001
Scale 1:977,993

Appendix E. Species that contributed to the selection of portions of the Imnaha subbasin in the conservation Portfolio for the Middle Rockies-Blue Mountain Ecoregion

Appendix Table 3. Species that contributed to the selection of portions of the Imnaha subbasin in the conservation Portfolio for the Middle Rockies-Blue Mountain Ecoregion (TNC 2003).

Common Name	Scientific Name
Fish and Wildlife Species	
Northern goshawk	*Accipiter gentilis*
White sturgeon	*Acipenser transmontanus*
Inland tailed frog	*Ascaphus montanusi*
Grey wolf	*Canis lupus*
Townsend's big-eared bat	*Corynorhinus townsendii*
Bobolink	*Dolichonyx oryzivorus*
American peregrine falcon	*Falco peregrinus anatum*
Shortface lanx	*Fisherola nuttalli*
Common loon	*Gavia immer*
California wolverine	*Gulo gulo luscus*
Harlequin duck	*Histrionicus histrionicus*
Wallowa rosy-finch	*Leucosticte tephrocotis wallowa*
Lynx	*Lynx canadensis*
Fisher	*Martes pennanti*
Steelhead	*Oncorhynchus mykiss mykiss*
Chinook	*Oncorhynchus tshawytscha*
Mountain quail	*Oreortyx pictus*
Flammulated owl	*Otus flammeolus*
Black-backed woodpecker	*Picoides arcticus*
Three-toed woodpecker	*Picoides tridactylus*
Bull trout	*Salvelinus confluentus*
Pygmy nuthatch	*Sitta pygmaea*
Siskiyou caddisfly	*Tinodes siskiyou*
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianus*
Plants	
Wallowa needlegrass	*Achnatherum wallowaensis*
Swamp onion	*Allium madidum*
Hells Canyon (eared) rockcress	*Arabis hastatula*
Wavy (scalloped) moonwort	*Botrychium crenulatum*
Cusick's camas	*Camassia cusickii*
Fraternal indian paintbrush	*Castilleja fraterna*
Curl-leaf mountain mahogany	*Cercocarpus ledifolius*
Beaked spikerush	*Eleocharis rostellata*
Davis' fleabane	*Erigeron engelmannii var. davisii*
Cliff buckwheat	*Eriogonum scopulorum*

Common Name	Scientific Name
Hazel's prickly phlox	*Leptodactylon pungens ssp. hazeliae*
Blue mountain biscuitroot	*Lomatium oreganum*
Membrane-leaved (thinsepal) monkeyflower	*Mimulus hymenophyllus*
Stalk-leaved monkeyflower	*Mimulus patulus*
MacFarlane's four o'clock	*Mirabilis macfarlanei*
Least (small) phacelia	*Phacelia minutissima*
Barton's raspberry	*Rubus bartonianus*
Spalding's silene	*Silene spaldingii*
Sand dropseed	*Sporobolus cryptandrus*
Plant Associations and Habitats	
Grand fir	*Abies grandis*
Grand fir/Idaho goldthread	*Abies grandis/Coptis occidentalis*
Subalpine fir	*Abies lasiocarpa*
Subalpine fir/whitebark pine	*Abies lasiocarpa/Pinus albicaulis*
Netleaf hackberry/bluebunch wheatgrass	*Celtis reticulata/Pseudoroegneria spicata*
Curl-leaf mountain mahogany/mountain snowberry	*Cercocarpus ledifloius/Symphoricarpos oreophilus*
Onespike danthonia/Sandberg bluegrass	*Danthonia unispicata/Poa secunda*
Parsnipflower buckwheat/bluebunch wheatgrass	*Eriogonum heracleoides/Pseudoregneria spicata*
Western larch	*Larix occidentalis*
Lodgepole pine	*Pinus contorta*
Ponderosa Pine Forest and Woodland	*Pinus ponderosa*
Quaking aspen, black hawthorn, common snowberry	*Populus tremuloides/Crataegus douglasii/Symphoricarpos albus*
Douglas-fir	*Pseudotsuga menziesii*
Douglas-fir/brand fir	*Pseudotsuga menziesii/Abies grandis*
Douglas-fir/lodgepole pine	*Pseudotsuga menziesii/Pinus contorta*
Western red cedar	*Thuja plicata*
Alpine	various
Badlands/Breaks	various
Bitterbrush	various
Canyon Grasslands	various
Mesic Upland Shrubs	various
Mixed Mesic Forest	various
Mixed Sagebrush Steppe	various
Native Grass or Forb	various
Subalpine Meadow	various

Appendix F. Federal Species of Concern-Wallowa County

<u>Mammals</u>	
Pale western big-eared bat	*Corynorhinus (=Plecotus) townsendii pallescens*
Pacific big-eared bat	*Corynorhinus (=Plecotus) townsendii townsendii*
California wolverine	*Gulo gulo luteus*
Silver-haired bat	*Lasionycteris noctivagans*
Pacific fisher	*Martes pennanti pacifica*
Small-footed myotis (bat)	*Myotis ciliolabrum*
Long-eared myotis (bat)	*Myotis evotis*
Fringed myotis (bat)	*Myotis thysanodes*
Long-legged myotis (bat)	*Myotis volans*
Yuma myotis (bat)	*Myotis yumanensis*
California bighorn sheep	*Ovis canadensis californiana*
Preble's shrew	*Sorex preblei*
<u>Birds</u>	
Northern goshawk	*Accipiter gentilis*
Western burrowing owl	*Athene cunicularia hypugea*
Ferruginous hawk	*Buteo regalis*
Olive-sided flycatcher	*Contopus cooperi (=borealis)*
Willow flycatcher	*Empidonax traillii adastus*
Harlequin duck	*Histrionicus histrionicus*
Yellow-breasted chat	*Icteria virens*
Lewis' woodpecker	*Melanerpes lewis*
Mountain quail	*Oreortyx pictus*
White-headed woodpecker	*Picoides albolarvatus*
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianus*
<u>Amphibians and Reptiles</u>	
Tailed frog	*Ascaphus truei*
<u>Fish</u>	
Pacific lamprey	*Lampetra tridentata*
Interior redband trout	*Oncorhynchus mykiss gibbsi*
<u>Invertebrates</u>	
Great Columbia River spire snail	*Fluminicola columbianus*
Siskiyou caddisfly	*Tinodes siskiyou*
<u>Plants</u>	
Wallowa ricegrass	*Achnatherum wallowaensis*
Blue Mountain onion	*Allium dictuon*
Hells Canyon rockcress	*Arabis hastatula*
Upward-lobed moonwort	*Botrychium ascendens*
Crenulate grape fern	*Botrychium crenulatum*
Twinspike moonwort	*Botrychium paradoxum*
Stalked moonwort	*Botrychium pedunculosum*
Fraternal paintbrush	*Castilleja fraterna*
Purple alpine paintbrush	*Castilleja rubidia*
Hazel's prickly-phlox	*Leptodactylon pungens* ssp. *hazeliae*
Greenman's desert parsley	*Lomatium greenmanii*
Membrane-leaved monkeyflower	*Mimulus hymenophyllus*

Appendix G. PACFISH/INFISH PFC Matrix

Appendix Table 4. Matrix of pathways and indicators (reproduced from (National Marine Fisheries Service 1996)

Pathway/Indicators	Properly Functioning	At Risk	Not Properly Functioning
Water Quality			
Temperature (1)	50-57°F (max 7-day average)	57-60°F (max 7-day-spawning) 57-64°F (migration/rearing)	>60°F (max 7-day spawning) >64°F (migration/rearing)
Sediment/Substrate (1)	Embeddedness <20%. Dominant substrate is gravel or cobble. Gravel/cobble bars stable. Turbidity low.	Embeddedness 20-30%. Gravel and cobble is subdominant. Gravel/cobble bars are in the process of stabilizing. Turbidity moderate.	Embeddedness >30%. Bedrock, sand, silt, or small gravel dominant. Gravel/cobble bars very mobile. Turbidity high.
Chemical Contamination	Low levels of chemical contamination; no CWA 303(d) designated reaches.	Moderate levels of chemical contamination; one CWA 303(d) designated reach.	High levels of chemical contamination; more than one CWA 303(d) designated reach.
Habitat Access			
Physical Barriers	Man-made barriers do not restrict fish passage.	Man-made barriers present restrict fish passage at base/low flows.	Man-made barriers present restrict fish passage at a range of flow conditions.
Habitat Elements			
Large Woody Material (1) >20 pieces/mi.	Meets standards (left). Adequate sources for LWM recruitment from riparian areas.	Currently meets standards for properly functioning, but lacks potential sources from riparian areas of LWM recruitment to maintain that standard, *or* Doesn't meet standard, but has recruitment potential.	Does not meet standards for properly functioning and lacks potential LWM recruitment.
Pool Frequency and Quality (1) Width (ft.) — Pools/mi. 5 — 184 10 — 96 15 — 70 20 — 56 25 — 47 50 — 26	Meets pool frequency standards (left) and LWM recruitment standards for properly functioning habitat, or has adequate flow and bedrock to maintain pools. Residual (holding) pool depth greater than 3 meters with good cover and cool water. Minor reduction of pool volume by fine sediment acceptable.	Meets pool frequency standards (left) but LWM recruitment standards inadequate to maintain pools over time. Lacks adequate flow or bedrock to form stable pools. Residual (holding) pool depth less than 3 meters with less than adequate cover/temperature. Moderate reduction in pool volume by fine sediment.	Does not meet pool frequency standards. Does not contain deep pools. Pool volumes are reduced by fine sediment.
Off-Channel habitat	Natural potential *or* backwaters with cover and low energy off-channel areas	Some backwater and high-energy side channels.	Few or no backwaters; no off-channel ponds.
Refugia	Habitat refugia exists and are buffered	Habitat refugia exists but are not adequately buffered	Habitat refugia does not exist.
Channel Conditions and Dynamics			
Width:Depth ratio (1)	Meet Rosgen's classification system (Rosgen 1996).	Does not meet Rosgen's classification system, but morphology/vegetation components are in place and system is moving towards meeting this classification.	Does not meet Rosgen's classification system and morphology/vegetation components are not in place.
Streambank Condition (1)	≥90% stable.	80-90% stable.	<80% stable.
Floodplain Connectivity	Off-channel areas are hydrologically connected to the main channel. Overbank flows occur and maintain wetland functions, riparian vegetation and succession, where channel type allows.	Reduced linkage of wetland floodplains. Overbank flows are reduced relative to historic frequency as evidenced by moderate degradation of wetland function, where channel type allows formation of wetlands.	Severe reduction in hydrologic connectivity. Wetland functions degraded, where channel type allows formation of wetlands.

Pathway/Indicators	Properly Functioning	At Risk	Not Properly Functioning
Hydrology			
Changes in Peak/Base Flow	Watershed hydrographs indicated peak flow, base flow, and flow timing characteristics comparable to an undisturbed watershed.	Some evidence of altered peak flow, base flow, and/or flow timing.	Pronounced changes in peak flow, base flow, and/or flow timing.
Increase in Drainage Network	Zero or minimum increase in drainage network density due to roads.	Moderate increases in drainage network density due to roads (5%).	Significant increases in drainage network density due to roads (>20%).
Watershed Conditions			
Road Density and Location	<2 mi/sq.mi.; no valley bottom roads.	2-3 mi/sq.mi.; some valley bottom roads.	>3 mi/sq.mi.; many valley bottom roads.
Disturbance History	<15% ECA with no concentration of disturbance in unstable areas or riparian areas.	<15% ECA with some disturbance in unstable areas or riparian areas.	>15% ECA with disturbance concentrated in unstable areas or riparian areas.
Riparian Reserves	Riparian reserves provide shade, LWM recruitment, habitat protection, and connectivity in all subwatersheds. Riparian plant community has the vigor, health, composition and diversity to support riparian reserve values.	Moderate loss of connectivity or function or riparian reserves. Riparian plant community lacking the vigor, health, composition and/or diversity to support riparian reserve values, but is in an upward trend.	Riparian reserves are fragmented with poor connectivity and little protection of habitats. Riparian plant community lacking the vigor, health, composition and/or diversity to support riparian reserve values, and is in a static or downward trend.

Appendix H. Descriptions of Forest and Grassland Structural Conditions (Johnson and O'Neil 2001).

Table 111. Descriptions of structural conditions in forest habitats

Structural Condition	Description
Grass/Forb–Open	Grass/Forb dominated with <70% coverage by grasses and forbs. Shrubs and small seedlings may be present, but do not dominate stand, (seedlings < 10% canopy cover), and there can be remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover.
Grass/Forb–Closed	Grass/Forb dominated with >70% coverage by grasses and forbs. Shrubs and small seedlings may be present, but do not dominate stand, (seedlings < 10% canopy cover), and there can be remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover.
Shrub/Seedling–Open	Seedlings are large enough to add structure to the stand but are small enough that the structure is similar to shrubs and may have remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover. There is <70% cover of shrubs or seedlings. Tree size has <1" dbh, and there is only a single canopy stratum.
Shrub/Seedling–Closed	Seedlings are large enough to add structure to the stand but are small enough that the structure is similar to shrubs. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is >70% cover of shrubs or seedlings. Tree size has <1" dbh, and there is only a single canopy stratum.
Sapling/Pole–Open	The canopy is open enough that understory vegetation may be abundant. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of sapling and pole-sized trees. Tree size is 1"-9" dbh, and there is a single canopy stratum.
Sapling/Pole–Moderate	Understory development is hampered by available light and moisture. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of sapling and pole-sized trees. Tree size is 1"-9" dbh, and there is a single canopy stratum.
Sapling/Pole–Closed	The understory is depauperate or absent. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is > 70% cover of sapling and pole-sized trees. Tree size is 1"- 9" dbh and there is a single canopy stratum.
Small Tree–Single Story–Open	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of small trees, with <10% cover of other tree sizes. Tree size is 10-14" dbh, and there is a single canopy stratum.
Small Tree–Single Story–Moderate	Some grass/forb or shrub understory may be present. Remnant trees (green trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of small trees with <10% cover of other sized trees. Tree size is 10-14" dbh, and there is a single canopy stratum.
Small Tree–Single Story–Closed	Grass/Forb or shrub understory minor or absent. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is > 70% cover of small trees, with <10% cover of other sized trees. Tree size is 10-14" dbh, and there is a single canopy stratum.

Structural Condition	Description
Medium Tree–Single Story–Open	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of medium trees, with <10% cover of other sized trees. Tree size is 15-19” dbh, and there is a single canopy stratum.
Medium Tree–Single Story–Moderate	Grass/Forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of medium trees with <10% cover of other sized trees. Tree size is 15-19” dbh, and there is a single canopy stratum.
Medium Tree–Single Story–Closed	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is >70% cover of medium trees with <10% cover of other sized trees. Tree size is 15-19” dbh, and there is a single canopy stratum.
Large Tree–Single Story–Open	Grasses, shrubs, and/or seedlings may occur in the understory. There is 10-39% cover of large and/or giant size trees with <10% cover of other sized trees. Tree size is 20”-29” dbh, and there is a single canopy stratum.
Large Tree–Single Story–Moderate	Some grass/forb or shrub understory may be present. There is 40-69% cover of large and/or giant trees with <10% cover of other sized trees. Tree size is 20”-29” dbh, and there is a single canopy stratum.
Large Tree–Single Story–Closed	Grasses, shrubs, and/or seedlings may occur in the understory. There is >70% cover of large and/or giant trees with <10% cover of other sized trees. Tree size is 20”-29” dbh, and there is a single canopy stratum.
Small Tree–Multistory–Open	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present. There is 10-39% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10”-14” dbh, and there are two or more canopy strata.
Small Tree–Multistory–Moderate	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 40-69% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10”-14” dbh, and there are two or more canopy strata.
Small Tree–Multistory–Closed	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory extremely limited or absent. There is >70% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10-14” dbh, and there are two or more canopy strata.

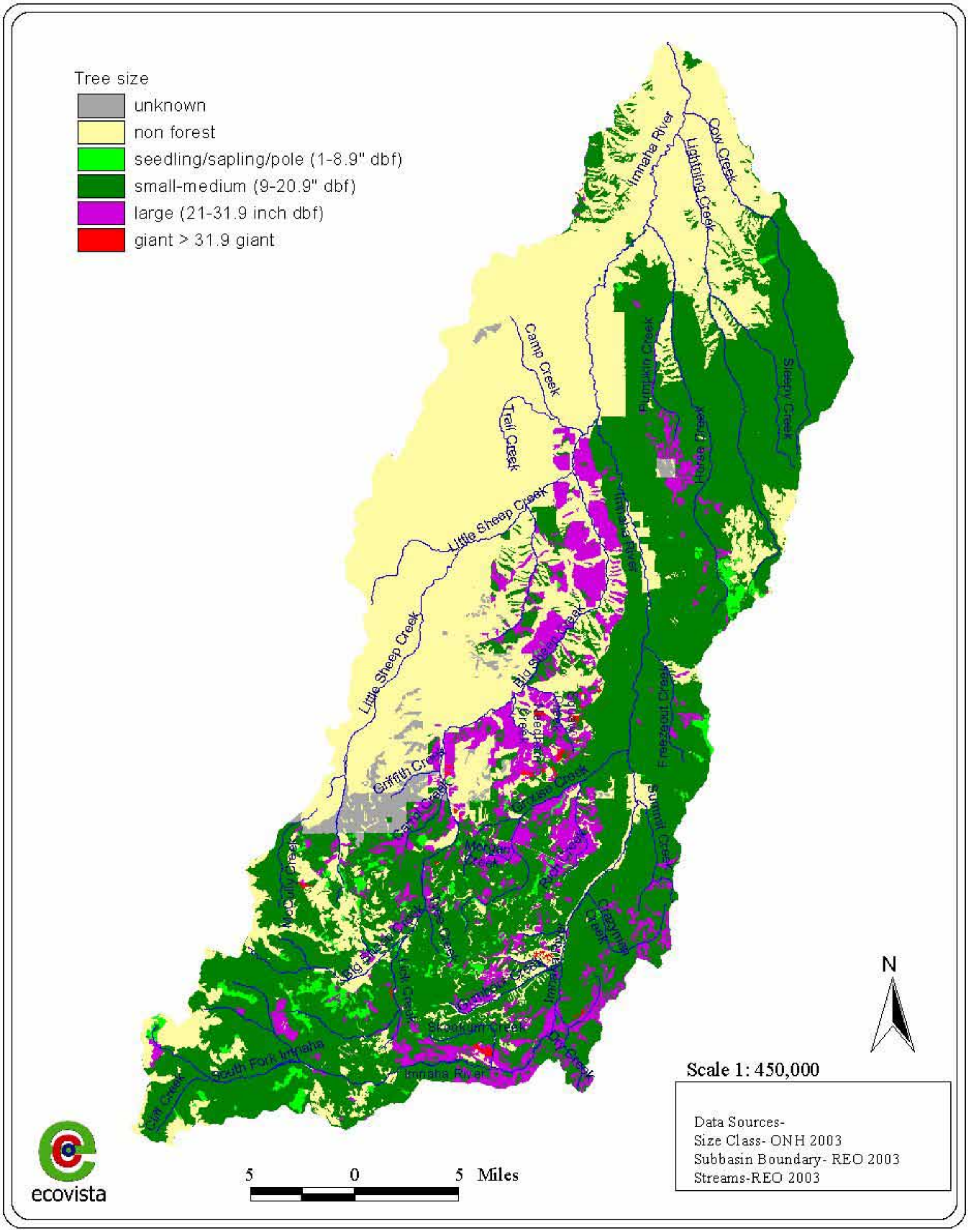
Structural Condition	Description
Medium Tree - Multistory- Open	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 10-39% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15"-19" dbh, and there are two or more canopy strata.
Medium Tree– Multistory– Moderate	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 40-69% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15"-19" dbh, and there are two or more canopy strata.
Medium Tree– Multistory– Closed	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb understory may be present, but is probably limited. There is >70% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15"- 19" dbh, and there are two or more canopy strata.
Large Tree– Multistory– Open	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands > 40% cover of giant trees are classified in the "Giant, multistoried" stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is 10-39% total canopy cover, with at least 10% or more canopy cover from large and/or giant trees and another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20"-29" dbh, and there are two or more canopy strata.
Large Tree– Multistory– Moderate	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands > 40% cover of giant trees are classified in the "Giant, multistoried" stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is 40-69% total canopy cover, at least 10% or more canopy cover from large trees with another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20"-29" dbh, and there are two or more canopy strata.
Large Tree– Multistory– Closed	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands > 40% cover of giant trees are classified in the "Giant, multistoried" stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is >70% total canopy cover, at least 10% or more canopy cover from large trees with another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20"- 29" dbh, and there are two or more canopy strata.
Giant Tree– Multistory	These stands have an overstory of giant sized trees with one or more distinct canopy layers of smaller trees. Stands with <40% canopy cover are classified in the "large tree–multistory–open", stage. There is > 40% canopy cover. Tree size is > 30" dbh, and there are two or more canopy strata.

Table 112. Descriptions of structural conditions in grassland habitats

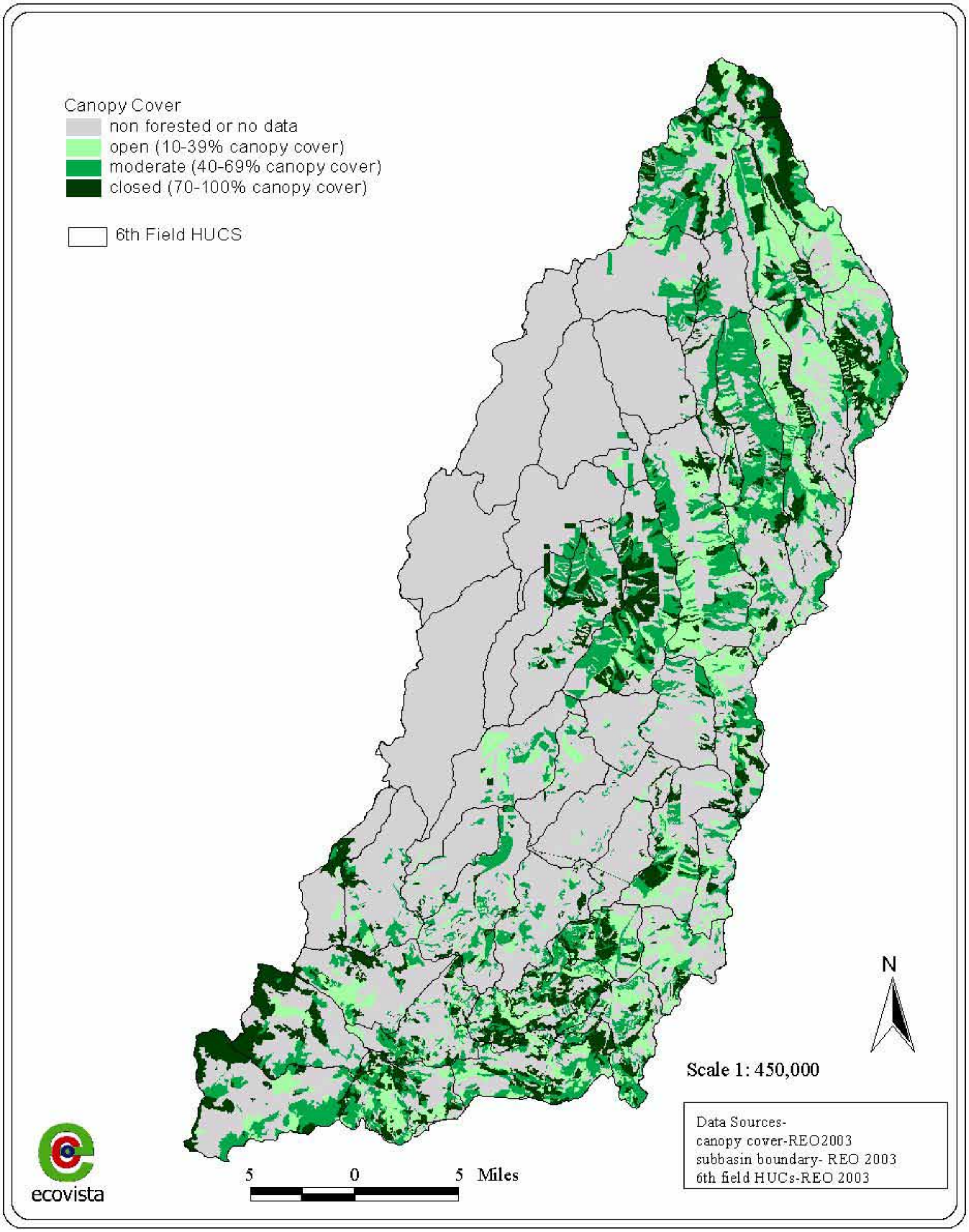
Structural Condition	Description
Grass/Forb - Open	Grasslands that have <10% shrub cover and < 10% tree canopy cover. Grasses and forbs cover less than 70% of the ground, and bare ground is evident.
Grass/Forb– Closed	Grasslands that have <10% shrub cover and <10% tree canopy cover. Grasses and forbs cover >70% of the ground.
Low shrub– Open Shrub Overstory– Seedling/Young	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Low shrub– Open Shrub Overstory– Mature	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is < 25%.
Low shrub– Open Shrub Overstory– Old	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is > 25%.
Low shrub– Closed Shrub Overstory– Seedling/Young	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Low shrub– Closed Shrub Overstory– Mature	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover < 10%. Crown decadence is < 25%.
Low shrub– Closed Shrub Overstory– Old	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover. Crown decadence is > 25%.
Medium shrub– Open Shrub Overstory– Seedling/Young	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Medium shrub– Open Shrub Overstory Mature	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is < 25%.

Structural Condition	Description
Medium shrub– Open Shrub Overstory– Old	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is > 25%.
Medium shrub–Closed Shrub Overstory–Seedling/Young	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have < 10% tree canopy cover. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Medium shrub– Closed Shrub Overstory– Mature	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have < 10% tree canopy cover. Crown decadence is < 25%
Medium shrub– Closed Shrub Overstory– Old	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have < 10% tree canopy cover. Crown decadence is > 25%.
Tall shrub– Open Shrub Overstory– Seedling/Young	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70%, and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Tall shrub– Open Shrub Overstory– Mature	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70% and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is < 25%.
Tall shrub– Open Shrub Overstory– Old	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70%, and may have tree canopy cover < 10%. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is > 25%.
Tall shrub– Closed Shrub Overstory– Seedling/Young	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >70%, and may have tree canopy cover < 10%. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Tall shrub– Closed Shrub Overstory– Mature	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >70%, and may have tree canopy cover < 10%. Crown decadence is < 25%.
Tall shrub– Closed Shrub Overstory– Old	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6- 16.5 ft) and shrub canopy cover >70%, and may have < 10% tree canopy cover. Crown decadence is > 25%.

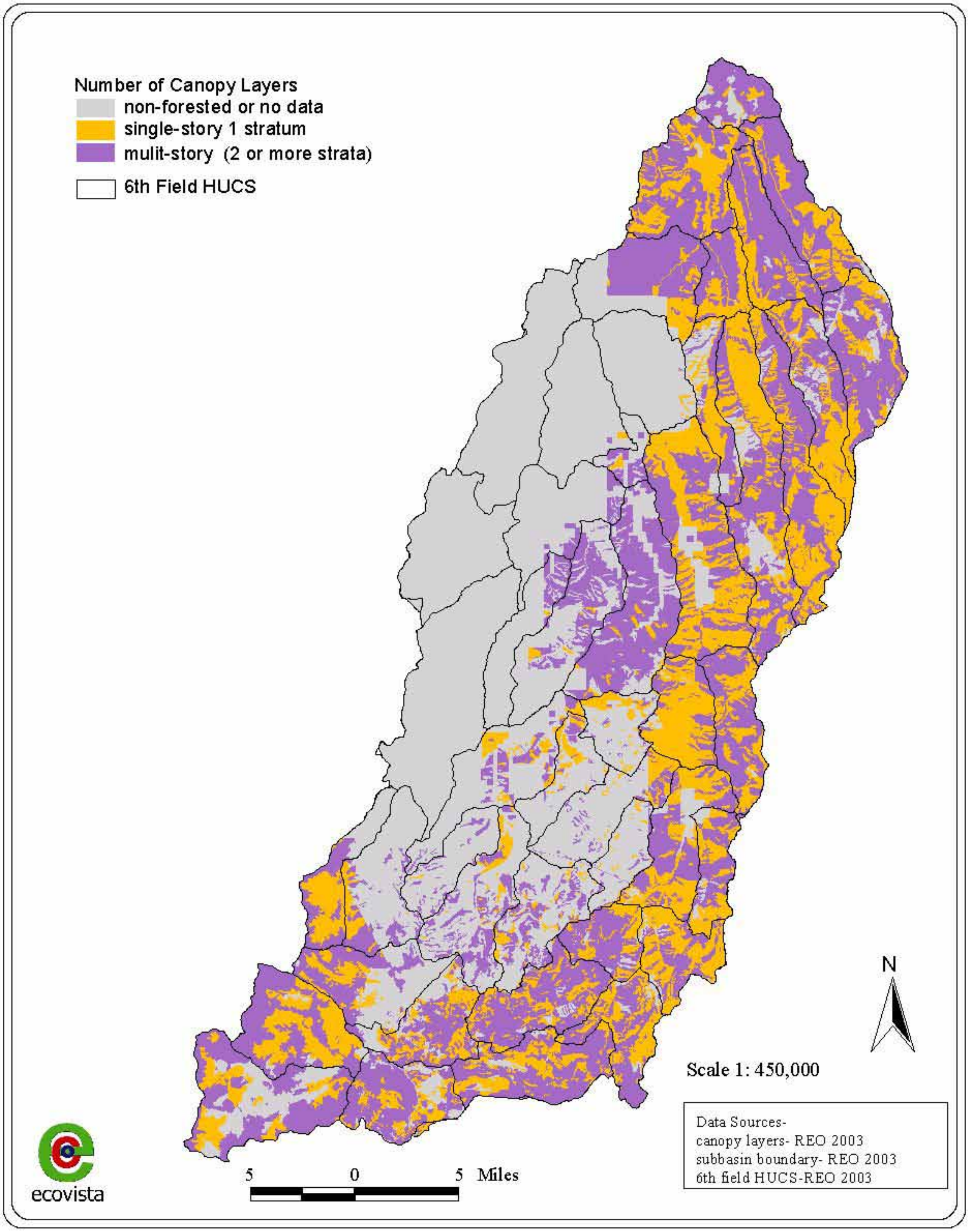
Appendix I. GIS layers used in determining forest structural condition



Distribution of tree sizes, Imnaha subbasin.



Forest canopy cover in the Imnaha subbasin.



Number of forest canopy layers in the Imnaha subbasin.

Appendix J. Definitions of Key Environmental Correlates (Johnson and O'Neil 2001).

FOREST, SHRUBLAND AND GRASSLAND HABITAT ELEMENTS

Biotic, naturally occurring attributes of forest and shrubland communities and the information that follows are for positive relationships only.

1.1 forest/woodland vegetative elements or substrates *- Biotic components found within a forested context and these are positive influences only.*

1.1.1 down wood - Includes downed logs, branches, and rootwads.

1.1.1.1 decay class **-** A system by which down wood is classified based on its deterioration.

1.1.1.1.1 hard [class 1, 2] - Little wood decay evident; bark and branches present; log resting on branches, not fully in contact with ground; includes classes 1 and 2 as described in Thomas (1979).

1.1.1.1.2 moderate [class 3] - Moderate decay present; some branches and bark missing or loose; most of log in contact with ground; includes class 3 as described in Thomas (1979).

1.1.1.1.3 soft [class 4, 5] - Well decayed logs; bark and branches missing; fully in contact with ground; includes classes 4 and 5 as described in Thomas (1979).

1.1.1.2 down wood in riparian areas - Includes down wood in the terrestrial portion of riparian zones in forest habitats. Does not refer to in-stream woody debris.

1.1.1.3 down wood in upland areas - Includes downed wood in upland areas of forest habitats.

1.1.2 litter - The upper layer of loose, organic (primarily vegetative) debris on the forest floor. Decomposition may have begun, but components still recognizable.

1.1.3 duff - The matted layer of organic debris beneath the litter layer. Decomposition more advanced than in litter layer; intergrades with uppermost humus layer of soil.

1.1.4 shrub layer - Refers to the shrub strata within forest stands.

1.1.4.1 shrub size - Refers to shrub height.

1.1.4.2 percent shrub canopy cover - Percent of ground covered by vertical projection of shrub crown diameter.

1.1.4.3 shrub canopy layers - Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies in the forest understory.

1.1.5 moss - Large group of green plants without flowers but with small leafy stems growing in clumps.

1.1.6 flowers - A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.

1.1.7 lichens - Any of a various complex of lower plants made up of an alga and a fungus growing as a unit on a solid surface.

1.1.8 forbs - Broad-leaved herbaceous plants. Does not include: grasses, sedges or rushes.

1.1.9 cactus - Any of a large group of drought-resistant plants with fleshy, usually jointed stems and leaves replaced by scales or prickles.

1.1.10 fungi - Mushrooms, molds, yeasts, rusts, etc.

1.1.11 roots, tubers, underground plant parts - Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.

1.1.12 ferns - Any of a group of flowerless, seedless vascular green plants.

1.1.13 herbaceous layer - Understory non-woody vegetation layer beneath shrub layer (forest context). May include forbs, grasses, ferns.

1.1.14 trees - Includes both coniferous and hardwood species.

1.1.14.1 snags - Standing dead trees.

1.1.14.1.1 decay class - A system by which snags are classified based on their deterioration.

1.1.14.1.1.1 hard - Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown (1985).

1.1.14.1.1.2 moderate - Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown (1985).

1.1.14.1.1.3 soft - Well decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown (1985).

1.1.14.2 snag size - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

1.1.14.2.1 seedling <1" dbh
1.1.14.2.2 sapling/pole 1"-9" dbh
1.1.14.2.3 small tree 10"-14" dbh
1.1.14.2.4 medium tree 15"-19" dbh
1.1.14.2.5 large tree 20"-29" dbh
1.1.14.2.6 giant tree >= 30" dbh

1.1.14.3 tree size - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

1.1.14.3.1 seedling <1" dbh
1.1.14.3.2 sapling/pole 1"-9" dbh
1.1.14.3.3 small tree 10"-14" dbh
1.1.14.3.4 medium tree 15"-19" dbh
1.1.14.3.5 large tree 20"-29" dbh
1.1.14.3.6 giant tree >= 30" dbh

1.1.14.4 mistletoe brooms/witches brooms - Dense masses of deformed branches caused by any type of broom-forming parasite (fungal or plant).

1.1.14.5 dead parts of live tree - Portions of live trees with rot; can include broken tops; branches with decay; tree base with rot.

1.1.14.6 hollow living trees (chimney trees) - Tree bole with large hollow chambers.

1.1.14.7 tree cavities - Smaller chamber in a tree; can be in bole, limbs, or forks of live or dead trees. May be excavated or result from decay or damage.

1.1.14.8 bark - Includes crevices/fissures, and loose or exfoliating bark.

1.1.14.9 live remnant/legacy trees - A live mature or old-growth tree remaining from the previous stand. Context is remnant trees in recently harvested or burned stands up through young forested stands. See dead parts of live trees, hollow living trees, tree cavities, and bark to see which species benefit from remnant trees with these attributes.

1.1.14.10 large live tree branches - Large branches often growing horizontally out from the tree bole.

1.1.14.11 tree canopy layer - Refers to the strata occupied by tree crowns.

1.1.14.11.1 sub-canopy - The space below the predominant tree crowns.

1.1.14.11.2 above canopy - The space above the predominant tree crowns

1.1.14.11.3 tree bole - The tree trunk.

1.1.14.11.4 canopy - The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.

1.1.15 fruits/seeds/nuts - Plant reproductive bodies that are used by animals.

1.1.16 edges - The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together.

1.2 shrubland/grassland vegetative elements or substrates - *Biotic components found within a shrubland or grassland context and these are positive influences only.*

1.2.1 herbaceous layer - Zone of understory non-woody vegetation beneath shrub layer (non-forest context). May include forbs, grasses.

1.2.2 fruits/seeds/nuts - Plant reproductive bodies that are used by animals.

1.2.3 moss - Large group of green plants without flowers but with small leafy stems growing in clumps.

1.2.4 cactus - Any of a large group of drought-resistant plants with fleshy, usually jointed stems and leaves replaced by scales or prickles.

1.2.5 flowers - A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.

1.2.6 shrubs - Plant with persistent woody stems and less than 16 feet tall; usually produces several basal shoots as opposed to a single bole.

1.2.6.1 shrub size - Refers to shrub height.

1.2.6.1.1 small <20"

1.2.6.1.2 medium 20"- 6.5'

1.2.6.1.3 large 6.6' – 16.5'

1.2.6.2 percent shrub canopy cover - Percent of ground covered by vertical projection of shrub crown diameter.

1.2.6.3 shrub canopy layer - Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies.

1.2.6.3.1 sub-canopy - The space below the predominant shrub crowns.

1.2.6.3.2 above canopy - The space above the predominant shrub crowns.

1.2.7 fungi - Mushrooms, molds, yeasts, rusts, etc.

1.2.8 forbs - Broad-leaved herbaceous plants. Does not include: grasses, sedges or rushes.

1.2.9 bulbs/tubers - Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.

1.2.10 grasses - Members of the Graminae family.

1.2.11 cryptogamic crusts - Non-vascular plants that grow on the soil surface. Primarily lichens, mosses and algae. Often found in arid or semi-arid regions. May form soil surface pinnacles.

1.2.12 trees (located in a shrubland/grassland context) - Small groups of trees or isolated individuals.

1.2.12.1 snags - Standing dead trees.

1.2.12.1.1 decay class - System by which snags are classified based on their deterioration.

1.2.12.1.1.1 hard - Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown (1985).

1.2.12.1.1.2 moderate - Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown (1985).

1.2.12.1.1.3 soft - Well decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown (1985).

1.2.12.2 snag size (dbh) - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

1.2.12.2.1 shrub/seedling <1" dbh

1.2.12.2.2 sapling/pole 1"-9" dbh

1.2.12.2.3 small tree 10"-14" dbh

1.2.12.2.4 medium tree 15"-19" dbh

1.2.12.2.5 large tree 20"-29" dbh

1.2.12.2.6 giant tree >= 30" dbh

1.2.12.3 tree size - Measured in diameter at breast height (dbh) the standard measurement for standing trees taken at 4.5 feet above the ground.

1.2.12.3.1 shrub/seedling <1" dbh

1.2.12.3.2 sapling/pole 1"-9" dbh

1.2.12.3.3 small tree 10"-14" dbh

1.2.12.3.4 medium tree 15"-19" dbh

1.2.12.3.5 large tree 20"-29" dbh

1.2.12.3.6 giant tree >= 30" dbh

1.2.13 edges - The place where plant communities meet or where successional stages or vegetative conditions within plant communities come togethe

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2) <u>ECOLOGICAL HABITAT ELEMENTS</u>

Selected interspecies relationships within the biotic community, and they include both positive and negative influences.

2.1 exotic species - Exotic species are defined as any non-native plant or animal, including cats, dogs, and cattle.

2.1.1 plants - This field refers to the relationship between an exotic plant species and animal species.

2.1.2 animals - This field refers to the relationship between an exotic animal species and the animal species.

2.1.2.1 predation - The species queried is preyed upon by or preys upon an exotic species.

2.1.2.2 direct displacement - The species queried is physically displaced by an exotic species, either by competition or actual disturbance.

2.1.2.3 habitat structure change - The species queried is affected by habitat structural changes caused by an exotic species, for example, cattle grazing.

2.1.2.4 other - Any other effects of an exotic species on a native species (not used by panelists).

2.2 insect population irruptions - The species directly benefits from insect population eruptions (i.e., benefits from the insects themselves, not the resulting tree mortality or loss of foliage).

2.2.1 mountain pine beetle - The species directly benefits from mountain pine beetle eruptions.

2.2.2 spruce budworm - The species directly benefits from spruce budworm eruptions.

2.2.3 gypsy moth - The species directly benefits from gypsy moth eruptions.

2.3 beaver/muskrat activity - The results of beaver activity including dams, lodges, and ponds, that are beneficial to other species.

2.4 burrows - Aquatic or terrestrial cavities produced by burrowing animals that are beneficial to other species.

3) **<u>NON-VEGETATIVE, ABIOTIC, TERRESTRIAL HABITAT ELEMENTS</u>**

Non-living components found within any ecosystem. Primarily positive influences with a few exceptions as indicated.

3.1 rocks - Solid mineral deposits.

3.1.1 gravel - Particle size from 0.2 - 7.6 cm in diameter; gravel bars associated with streams and rivers are a separate category.

3.1.2 talus - Accumulations of rocks at the base of cliffs or steep slopes; rock/boulder sizes varied and determine what species can inhabit the spaces between them.

3.1.3 talus-like - Refers to areas that contain many rocks and boulders but are not associated with cliffs or steep slopes.

3.2 soils - Various soil characteristics.

3.2.1 soil depth - The distance from the top layer of the soil to the bedrock or hardpan below.

3.2.2 soil temperature - Any measure of soil temperature or range of temperatures that are key to the queried species.

3.2.3 soil moisture - The amount of water contained within the soil.

3.2.4 soil organic matter - The accumulation of decomposing plant and animal materials found within the soil.

3.2.5 soil texture - Refers to size distribution and amount of mineral particles (sand, silt, and clay) in the soil; examples are sandy clay, sandy loam, silty clay etc.

3.3 rock substrates - Various rock formations.

3.3.1 avalanche chute - An area where periodic snow or rock slides prevent the establishment of forest conditions; typically shrub and herb dominated (sitka alder and/or vine maple).

3.3.2 cliffs - A high, steep formation, usually of rock. Coastal cliffs are a separate category under Marine Habitat Elements.

3.3.3 caves - An underground chamber open to the surface with varied opening diameters and depths; includes cliff-face caves, intact lava tubes, coastal caves, and mine shafts.

3.3.4 rocky outcrops and ridges - Areas of exposed rock.

3.3.5 rock crevices - Refers to the joint spaces in cliffs, and fissures and openings between slab rock; crevices among rocks and boulders in talus fields are a separate category (talus).

3.3.6 barren ground - Bare exposed soil with >40% of area not vegetated; includes mineral licks and bare agricultural fields; natural bare exposed rock is under the rocky outcrop category.

3.3.7 playa (alkaline, saline) - Shallow desert basins that are without natural drainage-ways where water accumulates and evaporates seasonally.

3.4 snow - Selected features of snow.

3.4.1 snow depth - Any measure of the distance between the top layer of snow and the ground below.

3.4.2 glaciers, snow field - Areas of permanent snow and ice.

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4) <u>FRESHWATER RIPARIAN AND AQUATIC BODIES HABITAT ELEMENTS</u>

Includes selected forms and characteristics of any body of freshwater.

4.1 water characteristics - *Includes various freshwater attributes. Ranges of continuous attributes that are key to the queried species, if known, will be in the comments.*

4.1.1 dissolved oxygen - Amount of oxygen passed into solution.

4.1.2 water depth - Distance from the surface of the water to the bottom substrate.

4.1.3 dissolved solids - A measure of dissolved minerals in water.

4.1.4 water pH - A measure of water acidity or alkalinity.

4.1.5 water temperature - Water temperature range that is key to the queried species, if known, is in the comments field.

4.1.6 water velocity - Speed or momentum of water flow.

4.1.7 water turbidity - Refers to the amount of roiled sediment within the water.

4.1.8 free water - Water derived from any source.

4.1.9 salinity and alkalinity - The presence of salts.

4.2 rivers & streams - Various characteristics of streams and rivers.

4.2.1 oxbows - A pond or wetland created when a river bend is cut off from the main channel of the river.

4.2.2 order and class - Systems of stream classification.

4.2.2.1 intermittent - Streams/rivers which contain non-tidal flowing water for only part of the year, water may remain in isolated pools.

4.2.2.2 upper perennial - Streams/rivers with a high gradient, fast water velocity, no tidal influence, some water flowing throughout the year, substrate consists of rock, cobbles, or gravel with occasional patches of sand, little floodplain development.

4.2.2.3 lower perennial - Streams/rivers with a low gradient, slow water velocity, no tidal influence, some water flowing throughout the year, substrate consists mainly of sand and mud, floodplain is well developed.

4.2.3 zone - System of water body classification based on the horizontal strata of the water column.

4.2.3.1 open water - Open water areas not closely associated with the shoreline or bottom.

4.2.3.2 submerged/benthic - Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.

4.2.3.3 shoreline - Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.2.4 in-stream substrate - The bottom materials in a body of water.

4.2.4.1 rocks - Rocks > 256 mm (10") in diameter.

4.2.4.2 cobble/gravel - Rocks or pebbles, 4-256 mm in diameter (10), substrata may consist of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

4.2.4.3 sand/mud - Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.

4.2.5 vegetation - Herbaceous plants.

4.2.5.1 submergent vegetation - Rooted aquatic plants that do not emerge above the water surface.

4.2.5.2 emergent vegetation - Rooted aquatic plants that emerge above the water surface.

4.2.5.3 floating mats - Un-rooted plants that form vegetative masses on the surface of the water.

4.2.6 coarse woody debris in streams and rivers - Any piece of woody material (debris piles, stumps, root wads, fallen trees) that intrudes into or lies within a river or stream.

4.2.7 pools - Portions of the stream with reduced current velocity, often with water deeper than surrounding areas.

4.2.8 riffles - Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.

4.2.9 runs/glides - Areas of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

4.2.10 overhanging vegetation - Herbaceous plants that cascade over stream and river banks and are < 1 meter above the water surface.

4.2.11 waterfalls - Steep decent of water within a stream or river.

4.2.12 banks - Rising ground that borders a body of water.

4.2.13 seeps or springs - A concentrated flow of ground water issuing from openings in the ground.

4.3 ephemeral pools - Pools that contain water for only brief periods of time usually associated with periods of high precipitation.

4.4 sand bars - Exposed areas of sand or mud substrate.

4.5 gravel bars - Exposed areas of gravel substrate.

4.6 lakes/ponds/reservoirs - Various characteristics of lakes, ponds, and reservoirs.

4.6.1 zone - System of water body classification based on the horizontal strata of the water column.

4.6.1.1 open water - Open water areas not closely associated with the shoreline or bottom substrates.

4.6.1.2 submerged/benthic - Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.

4.6.1.3 shoreline - Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.6.2 in-water substrate - The bottom materials in a body of water.

4.6.2.1 rock - Rocks > 256 mm (10 inches) in diameter.

4.6.2.2 cobble/gravel - Rocks or pebbles, 4-256 mm in diameter, substrata may consist of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

4.6.2.3 sand/mud - Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.

4.6.3 vegetation - Herbaceous plants.

4.6.3.1 submergent vegetation - Rooted aquatic plants that do not emerge above the water surface.

4.6.3.2 emergent vegetation - Rooted aquatic plants that emerge above the water surface.

4.6.3.3 floating mats - Unrooted plants that form vegetative masses on the surface of the water.

4.6.4 size - Refers to whether or not the species is differentially associated with water bodies based on their size.

4.6.4.1 ponds - <2ha

4.6.4.2 lakes - >=2ha

4.7 wetlands/marshes/wet meadows/bogs and swamps - Various components and characteristics related to any of these systems.

4.7.1 riverine wetlands - Wetlands found in association with rivers.

4.7.2 context - When checked, indicates that the setting of the wetland, marsh, wet meadow, bog or swamp is key to the queried species.

4.7.2.1 forest - Wetlands within a forest.

4.7.2.2 non-forest - Wetlands that are not surrounded by forest.

4.7.3 size - When checked, indicates that the queried species is differentially associated with a wetland, marsh, wet meadow, bog or swamp based on the size of the water body.

4.7.4 marshes - Frequently or continually inundated wetlands characterized by emergent herbaceous vegetation (grasses,sedges, reeds) adapted to saturated soil conditions.

4.7.5 wet meadows - Grasslands with waterlogged soil near the surface but without standing water for most of the year.

4.8 islands - A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water.

4.9 seasonal flooding - Flooding that occurs periodically due to precipitation patterns.

5) MARINE HABITAT ELEMENTS

Selected biotic and abiotic components and characteristics of marine systems.

5.1 zone - System of marine classification based on water depth, and relationship to substrate.

5.1.1 supratidal - The zone that extends landward from the higher high water line up to either the top of a coastal cliff or the landward limit of marine process (i.e., storm surge limit).

5.1.2 intertidal - The zone between the higher high water line and the lower low water line.

5.1.3 nearshore subtidal - The zone that extends from the lower low water line seaward to the 20 meter isobath, typically within 1 kilometer of shore.

5.1.4 shelf - The area between the 20 and 200 meter isobath, typically within 60 kilometers of shore.

5.1.5 oceanic - The zone that extends seaward from the 200 meter isobath.

5.2 substrates - The bottom materials in a body of water.

5.2.1 bedrock - The solid rock underlying surface materials.

5.2.2 boulders - Large, worn, rocks > 256 mm (10 inches) in diameter.

5.2.3 hardpan - Consolidated clays forming a substratum firm enough to support an epibenthos and too firm to support a normal infauna (clams, worms, etc.), but with an unstable surface which sloughs frequently.

5.2.4 cobble - Rocks or pebbles, 64-256 mm in diameter, may be a mix of cobbles, gravel, shells, and sand, with no one type exceeding 70 percent cover.

5.2.5 mixed-coarse - Substrata consisting of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

5.2.6 gravel - Small rocks or pebbles, 4-64 mm in diameter.

5.2.7 sand - Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.

5.2.8 mixed-fine - Mixture of sand and mud particles < 4 mm in diameter, little gravel present.

5.2.9 mud - Fine substrata < 0.06 mm in diameter, little gravel present, usually mixed with organics.

5.2.10 organic - Substrata composed primarily of organic matter such as wood chips, leaf litter, or other detritus.

5.3 energy - Degree of exposure to oceanic swell, currents, and wind waves.

5.3.1 protected - No sea swells, little or no current, and restricted wind fetch.

5.3.2 semi-protected - Shorelines protected from sea swell, but may receive waves generated by moderate wind fetch, and/or moderate to weak tidal currents.

5.3.3 partially exposed - Oceanic swell attenuated by offshore reefs, islands, or headlands, but shoreline substantially exposed to wind waves, and/or strong to moderated tidal currents.

5.3.4 exposed - Highly exposed to oceanic swell, wind waves, and/or very strong currents.

5.4 vegetation - Includes herbaceous plants and plants lacking vascular systems.

5.4.1 mixed macro algae - Includes brown, green, and red algae.

5.4.2 kelp - Subaquatic rooted vegetation found in the nearshore marine environment.

5.4.3 eelgrass - Subaquatic rooted vegetation found in an estuarine environment.

5.5 water depth - Refers to the vertical layering of the water column.

5.5.1 surface layer - The uppermost part of the water column.

5.5.1.1 tide rip - A current of water disturbed by an opposing current, especially in tidal water or by passage over an irregular bottom.

5.5.1.2 surface microlayer*(neuston)* - The thin uppermost layer of the water's surface.

5.5.2 euphotic - Upper layer of a water body that receives sufficient sunlight for the photosynthesis of plants.

5.5.3 disphotic - Area below the euphotic zone where photosynthesis ceases.

5.5.4 demersal/benthic - Submerged lands including vegetated and unvegetated areas.

5.6 water temperature - Measure of ocean water temperature.

5.7 salinity - The presence and concentration of salts; salinity range that is key to the species, if it is known, will be in the comments field. Positive or negative influences were noted.

5.8 forms - Morphological elements within marine areas.

5.8.1 beach - An accumulation of unconsolidated material (sand, gravel, angular fragments) formed by waves and wave-induced currents in the intertidal and subtidal zones.

5.8.2 off-shore islands/rocks/sea stacks/off-shore cliffs - A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water at higher high water for large (spring) tide. Includes off-shore marine cliffs.

5.8.3 marine cliffs *(mainland)* - A sloping face steeper than 20 degrees usually formed by erosional processes and composed of either bedrock and/or unconsolidated materials.

5.8.4 delta - An accumulation of sand, silt, and gravel deposited at the mouth of a stream where it discharges into the sea.

5.8.5 dune - In a marine context; a mound or ridge formed by the transportation and deposition of wind-blown material (sand and occasionally silt).

5.8.6 lagoon - Shallow depression within the shore zone continuously occupied by salt or brackish water lying roughly parallel to the shoreline and separated from the open sea by a barrier.

5.8.7 salt marsh - A coastal wetland area which is periodically inundated by tidal brackish or salt water and which supports significant (15% cover) non-woody vascular vegetation (e.g., grasses, rushes, sedges) for at least part of the year.

5.8.8 reef - A rock outcrop, detached from the shore, with maximum elevations below the high-water line.

5.8.9 tidal flat - A level or gently sloping (less than 5 degrees) constructional surface exposed at low tide, usually consisting primarily of sand or mud with or without detritus, and resulting from tidal processes.

5.9 water clarity - As influenced by sediment load.

6) *(No Data)* - Formerly contained topographic information such as elevation that has been moved to the life history matrix.

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7) <u>FIRE AS A HABITAT ELEMENT</u>

Refers to species that benefit from fire. The time frame after which the habitat is suitable for the species, if known, will be found in the comments field.

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8) <u>ANTHROPOGENIC - RELATED HABITAT ELEMENTS</u>

This section contains selected examples of human-related Habitat Elements that may be a key part of the environment for many species. These Habitat Element's may have either a negative or positive influence on the queried species.

8.1 campgrounds/picnic areas - Sites developed and maintained for camping and picnicking.

8.2 roads - Roads that are either paved or unpaved.

8.3 buildings - Permanent structures.

8.4 bridges - Permanent structures typically over water or ravines.

8.5 diseases transmitted by domestic animals - Some domestic animal diseases may be a source of mortality or reduced vigor for wild species.

8.6 animal harvest or persecution - Includes illegal harvest/poaching, incidental take (resulting from fishing net by-catch, or by hay mowing, for example), and targeted removal for pest control.

8.7 fences/corrals - Wood, barbed wire, or electric fences.

8.8 supplemental food - Food deliberately provided for wildlife (e.g. bird feeders, ungulate feeding programs, etc.) as well as spilled or waste grain along railroads and cattle feedlots.

8.9 refuse - Any source of human-derived garbage (includes landfills).

8.10. supplemental boxes, structures and platforms - Includes bird houses, bat boxes, raptor and waterfowl nesting platforms.

8.11 guzzlers and waterholes - Water sources typically built for domestic animal use.

8.12 toxic chemical use - Proper use of regulated chemicals; documented effects only.

8.12.1 herbicides/fungicides - Chemicals used to kill vegetation and fungi.

8.12.2 insecticides - Chemicals used to kill insects.

8.12.3 pesticides - Chemicals used to kill vertebrate species.

8.12.4 fertilizers - Chemicals used to enhance vegetative growth.

8.13 hedgerows/windbreaks - Woody and/or shrubby vegetation either planted or that develops naturally along fencelines and field borders.

8.14 sewage treatment ponds - Settling ponds associated with sewage treatment plants.

8.15 repellents - Various methods purposely used against wildlife species that damage crops or property (excluding pesticides and insecticides).

8.15.1 chemical *(taste, smell, or tactile)* - Chemical substances that repel wildlife.

8.15.2 noise or visual disturbance - Non-chemical methods to deter wildlife.

8.16 culverts - Drain crossings under roads or railroads.

8.17 irrigation ditches/canals - Ditches built to transport water to agricultural crops or to handle runoff.

8.18 powerlines/corridors - Utility lines, poles, and rights-of-way associated with transmission, telephone, and gas lines.

8.19 pollution - Human-caused environmental contamination.

8.19.1 chemical

8.19.2 sewage

8.19.3 water

8.20. piers

8.21 mooring piles, dolphins, buoys

8.22 bulkheads, seawalls, revetment

8.23 jetties, groins, breakwaters

8.24 water diversion structures

8.25 log boom

8.26 boats/ships

8.27 dredge spoil islands

8.28 hatchery facilities and fish

Appendix K. Key Environmental Correlates identified to impact habitat selection by the Imnaha subbasin focal species (Johnson and O'Neil 2001).

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1	**Forest, Shrubland, and Grassland Habitat Elements**	**All Terrestrial Focal Species**	**none noted**
1.1	forest/woodland vegetative elements or substrates	Long-toed salamander	none noted
		Flammulated owl	
		White-headed woodpecker	
		Boreal owl	
		Olive-sided flycatcher	
		Yellow warbler	
		Mountain quail	
		Bald eagle	
		Rocky Mountain elk	
		American marten	
		Rocky Mountain goat	
		Bighorn sheep	
		Mule deer	
1.1.1	down wood (includes downed logs, branches, and rootwads, in any context)	Long-toed salamander	none noted
		Rocky Mountain elk	none noted
		American marten	Will also use slash piles as shelter.
		Mule deer	none noted
1.1.1.2	down wood in riparian areas	Long-toed salamander	Cover is key for this species. Cover can include down wood, moss, rocks, or other items.
		American marten	none noted
1.1.1.3	down wood in upland areas	Long-toed salamander	Cover is key for this species. Cover can include down wood, moss, rocks, or other items.
		American marten	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.1.2	litter	Long-toed salamander	In some situations, in large riverine and cotton wood forest, litter might be an important cover element, in other situations its role is unknown.
1.1.3	duff	Long-toed salamander	Suspected to be important, but not studied. Cover is a key in some form for this species. Cover can include down wood, moss, rocks, or other items.
1.1.4	shrub layer	Yellow warbler	none noted
		Mountain quail	
		Rocky Mountain elk	
		Mule deer	
1.1.4.1	shrub size	Mountain quail	none noted
1.1.4.2	percent shrub canopy cover	Mountain quail	none noted
1.1.5	moss	Long-toed salamander	Cover is key for this species. Cover can include down wood, moss, rocks, or other items.
		Rocky Mountain goat	none noted
1.1.7	lichens	Rocky Mountain goat	Used as food.
1.1.8	forbs	Mountain quail	48% of their diet consists of legumes, Lotus, sweat peas, and alfalfa. The last one is highly preferred, especially when it is planted alongside roads, and not in the fields.
		Rocky Mountain elk	none noted
		Bighorn sheep	none noted
		Mule deer	none noted
1.1.11	roots, tubers, underground plant parts	Mountain quail	none noted
1.1.13	herbaceous layer	Mountain quail	none noted
		Rocky Mountain elk	
		Bighorn sheep	
		Mule deer	

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.1.14	trees	Flammulated owl	none noted
		White-headed woodpecker	none noted
		Boreal owl	Positive relationship between leaning trees and juvenile owls: they often climb them.
		Olive-sided flycatcher	Trees or snags that project above the surrounding canopy are of particular importance.
		Bald eagle	none noted
		American marten	none noted
		Rocky Mountain goat	none noted
1.1.14.1	snags	Flammulated owl	none noted
		White-headed woodpecker	none noted
		Boreal owl	none noted
		Olive-sided flycatcher	Used as hunting perches; snags that project above the surrounding canopy are particularly important.
		Bald eagle	none noted
		American marten	none noted
1.1.14.1.1	decay class	White-headed woodpecker	none noted
1.1.14.1.1.2	moderate [class 3]	White-headed woodpecker	none noted
1.1.14.2	snag size (dbh)	Flammulated owl	none noted
		White-headed woodpecker	Large snags are used for nesting.
		Boreal owl	none noted
		Bald eagle	none noted
		American marten	none noted
1.1.14.2.3	small tree 10–14in. dbh	Flammulated owl	none noted
		Boreal owl	
1.1.14.2.4	medium tree 15–19in. dbh	Flammulated owl	none noted
		White-headed woodpecker	
		Boreal owl	

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
		American marten	
1.1.14.2.5	large tree 20–29in. dbh	Flammulated owl	none noted
		White-headed woodpecker	
		Boreal owl	
		Bald eagle	
		American marten	
1.1.14.2.6	giant tree ≥ 30in. dbh	Flammulated owl	none noted
		White-headed woodpecker	
		Boreal owl	
		Bald eagle	
		American marten	
1.1.14.3	tree size (dbh)	Flammulated owl	none noted
		White-headed woodpecker	Large, live pine trees are important for foraging.
		Boreal owl	none noted
		Bald eagle	none noted
		American marten	none noted
1.1.14.3.3	small tree 10–14in. dbh	Flammulated owl	none noted
		Boreal owl	
1.1.14.3.4	medium tree 15–19in. dbh	Flammulated owl	none noted
		White-headed woodpecker	
		Boreal owl	
		American marten	
1.1.14.3.5	large tree 20–29in. dbh	Flammulated owl	none noted
		White-headed woodpecker	
		Boreal owl	
		Bald eagle	
		American marten	
1.1.14.3.6		Flammulated owl	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
	giant tree ≥ 30in. dbh	White-headed woodpecker	
		Boreal owl	
		Bald eagle	
		American marten	
1.1.14.4	mistletoe brooms/witches brooms	American marten	none noted
1.1.14.5	dead parts of live tree	Bald eagle	For hunting perches, roosts, nest placement.
1.1.14.7	tree cavities	Flammulated owl	Secondary cavity nester.
		Boreal owl	none noted
		American marten	May use for denning if large enough; also checks cavities for prey.
1.1.14.9	live remnant/legacy trees	White-headed woodpecker	Pines for foraging.
		Olive-sided flycatcher	none noted
		Bald eagle	none noted
		American marten	none noted
1.1.14.10	large live tree branches	American marten	none noted
1.1.14.11	tree canopy layer	Flammulated owl	none noted
		Olive-sided flycatcher	none noted
		Bald eagle	none noted
		American marten	In general, martens avoid stands that are less than 30% canopy cover.
1.1.14.11.1	subcanopy	Flammulated owl	none noted
		Bald eagle	Winter roosting.
1.1.14.11.2	above canopy	Olive-sided flycatcher	Prefers perches sticking above canopy.
		Bald eagle	Prefers nest sites/perches sticking above canopy
1.1.15	fruits/seeds/nuts	White-headed woodpecker	Pine seeds are important during fall.
		Mountain quail	none noted
1.1.16	edges	Long-toed salamander	none noted
		Boreal owl	Forest/grassland edge for foraging.

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
		Olive-sided flycatcher	Use juxtaposition of early and late successional stages.
		Mountain quail	none noted
		Bald eagle	none noted
		Rocky Mountain elk	none noted
		Rocky Mountain goat	none noted
		Bighorn sheep	none noted
		Mule deer	none noted
1.2	shrubland/grassland vegetative elements or substrates	Long-toed salamander	none noted
		Mountain quail	
		Grasshopper sparrow	
		Bald eagle	
		Rocky Mountain elk	
		Rocky Mountain goat	
		Bighorn sheep	
		Mule deer	
1.2.1	herbaceous layer	Mountain quail	none noted
		Grasshopper sparrow	
		Rocky Mountain elk	
		Rocky Mountain goat	
		Bighorn sheep	
		Mule deer	
1.2.2	fruits/seeds	Mountain quail	none noted
1.2.3	moss	Rocky Mountain goat	none noted
1.2.5	flowers	Mountain quail	none noted
1.2.6	shrubs	Mountain quail	none noted
		Rocky Mountain elk	
		Bighorn sheep	
		Mule deer	

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.2.6.1	shrub size (height)	Mountain quail	
		Bighorn sheep	
1.2.6.1.1	small (< 20 in.)	Bighorn sheep	
1.2.6.1.2	medium (20in.–6.5ft.)	Mountain quail	
1.2.6.1.3	large (6.6ft.–16.5ft.)	Mountain quail	
1.2.8	Shrub Canopy Layer	Mountain quail	none noted
		Rocky Mountain elk	
		Bighorn sheep	
		Mule deer	
1.2.9	bulbs/tubers	Mountain quail	none noted
1.2.10	grasses	Grasshopper sparrow	none noted
		Rocky Mountain elk	
		Bighorn sheep	
1.2.12	trees (located in a shrubland/grassland context)	Long-toed salamander	Down wood from trees might be important element in grasslands and shrublands.
		Bald eagle	none noted
		Rocky Mountain elk	Isolated or in small groups of trees or snags, regardless of size are important for thermal cover in the summer.
		Bighorn sheep	none noted
1.2.12.1	snags	Bald eagle	none noted
1.2.12.2	snag size (dbh)	Bald eagle	none noted
1.2.12.2.5	large tree 20–29 in. dbh	Bald eagle	none noted
1.2.12.2.6	giant tree ≥ 30 in. dbh	Bald eagle	none noted
1.2.12.3	tree size (dbh)	Bald eagle	none noted
	tree size (dbh)	Bighorn sheep	
1.2.12.3.2	sapling/pole 1–9 in. dbh	Bighorn sheep	none noted
1.2.12.3.3	small tree 10–14 in. dbh	Bighorn sheep	Isolated trees.
1.2.12.3.5	large tree 20–29 in. dbh	Bald eagle	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
1.2.12.3.6	giant tree ≥ 30 in. dbh	Bald eagle	none noted
1.2.13	edges	Long-toed salamander	Edges where grassland or shrubland meets an aquatic habitat.
		Mountain quail	none noted
		Bald eagle	none noted
		Rocky Mountain elk	none noted
		Rocky Mountain goat	none noted
		Bighorn sheep	none noted
		Mule deer	none noted
2	**Ecological Habitat Elements**	**Long-toed salamander**	**none noted**
		Flammulated owl	
		White-headed woodpecker	
		Yellow warbler	
		Mountain quail	
		Bald eagle	
		Rocky Mountain elk	
		American marten	
2.1	exotic species	Yellow warbler	none noted
		Mountain quail	
		Rocky Mountain elk	
2.1.1	exotic plants	Long-toed salamander	Effects unknown. Might be positive or negative (purple loosestrife).
		Mountain quail	Feeds on lotus (pea vine).
		Rocky Mountain elk	Himalayan blackberry and Scotch broom are negative; forage seed mixes are positive.
2.2	insect population irruptions (specify whether negative or positive relationship in comments)	Flammulated owl	none noted
		White-headed woodpecker	
		Yellow warbler	
2.2.2	spruce budworm	Flammulated owl	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
		White-headed woodpecker	
		Yellow warbler	
2.3	beaver/muskrat activity (dams, lodges, ponds) (Positive only)	Long-toed salamander	Likely to provide breeding habitat.
		Bald eagle	Beaver ponds.
2.4	burrows (aquatic or terrestrial) (Positive only)	Long-toed salamander	Terrestrial burrows are important, particularly in drier habitats.
		American marten	none noted
3	Nonvegetative, Abiotic Habitat Elements	Long-toed salamander	none noted
		Mountain quail	
		Rocky Mountain goat	
		Bighorn sheep	
3.1	rocks	Long-toed salamander	none noted
		Mountain quail	
		Bighorn sheep	
3.1.1	gravel	Long-toed salamander	Important as retreat sites (cover or overwintering).
		Mountain quail	Source of grit (smallest particle sizes).
3.1.2	talus	Long-toed salamander	Important as retreat sites (cover or overwintering).
		Bighorn sheep	none noted
3.1.3	talus-like habitats	Long-toed salamander	Important as retreat sites (cover or overwintering).
3.2	soils	Long-toed salamander	none noted
3.3	rock substrates	Rocky Mountain goat	Rock substrates are the key element for mountain goat; presence of rock is a primary determining factor of their occurrence.
		Bighorn sheep	none noted
3.3.1	avalanche chute	Rocky Mountain goat	none noted
		Bighorn sheep	

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
3.3.2	cliffs	Rocky Mountain goat	none noted
		Bighorn sheep	
3.3.4	rocky outcrops and ridges	Rocky Mountain goat	none noted
		Bighorn sheep	
3.3.5	rock crevices	Rocky Mountain goat	none noted
		Bighorn sheep	
3.3.6	barren ground	Bighorn sheep	Mineral licks.
3.4	snow	Rocky Mountain goat	none noted
3.4.2	glaciers, snow field (permanent snow/ice)	Rocky Mountain goat	none noted
4	Freshwater Riparian & Aquatic Bodies Habitat Elements	Long-toed salamander	none noted
		Olive-sided flycatcher	
		Yellow warbler	
		Mountain quail	
		Bald eagle	
		Rocky Mountain elk	
		American marten	
		Mountain goat	
		Bighorn sheep	
		Mule deer	
4.1	water characteristics (specify whether negative or positive relationship in comments)	Long-toed salamander	none noted
		Bald eagle	
		Rocky Mountain elk	
		Rocky Mountain goat	
		Bighorn sheep	
		Mule deer	
4.1.1	dissolved oxygen	Long-toed salamander	There is a low dissolved oxygen threshold.
4.1.2	water depth	Long-toed salamander	Long-toed salamanders require shallows for breeding and larval development.

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
4.1.6	water velocity	Long-toed salamander	Require still water.
4.1.7	water turbidity	Long-toed salamander	Negative relationship between water turbidity and reproduction.
		Bald eagle	Need clear water to see prey.
4.1.8	free water (derived from any source)	Rocky Mountain elk	none noted
		Rocky Mountain goat	Free water is necessary in drier habitats (East of the Cascades).
		Bighorn sheep	none noted
		Mule deer	none noted
4.2	rivers & streams	Long-toed salamander	none noted
		Mountain quail	
		Bald eagle	
4.2.1	oxbows	Long-toed salamander	Provide breeding habitat.
		Bald eagle	none noted
4.2.2	order and class	Long-toed salamander	none noted
		Bald eagle	
4.2.2.1	intermittent	Long-toed salamander	Provide breeding habitat.
4.2.2.2	upper perennial	Bald eagle	none noted
4.2.2.3	lower perennial	Bald eagle	none noted
4.2.3	zone	Long-toed salamander	none noted
		Bald eagle	
4.2.3.1	open water	Long-toed salamander	none noted
		Bald eagle	
4.2.3.3	shoreline	Long-toed salamander	none noted
4.2.7	pools	Bald eagle	none noted
4.2.13	seeps or springs	Long-toed salamander	
		Mountain quail	
4.3	ephemeral pools	Long-toed salamander	There must be standing bodies of water present, lasting long enough to permit metamorphosis.

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
		Bald eagle	Where fish or waterfowl are present.
4.4	sand bars	Bald eagle	none noted
4.5	gravel bars	Bald eagle	none noted
4.6	lakes/ponds/reservoirs	Long-toed salamander	none noted
		Bald eagle	
4.6.1	zone	Long-toed salamander	none noted
		Bald eagle	
4.6.1.1	open water	Long-toed salamander	none noted
		Bald eagle	
4.6.1.3	shoreline	Long-toed salamander	High degree of water fluctuations has a negative impact on salamanders.
4.6.2	in-water substrate	Long-toed salamander	Hiding places and cover from predatory invertebrates.
4.6.2.1	rock		
4.6.2.2	cobble/gravel		
4.6.2.3	sand/mud		
4.6.3	vegetation	Long-toed salamander	Oviposition sites and cover from fish and other predators.
4.6.3.1	submergent vegetation		
4.6.3.2	emergent vegetation		
4.6.3.3	floating mats		
4.7	wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)	Long-toed salamander	none noted
		Olive-sided flycatcher	Open bogs are favored, plus other wetland habitats where tall, remnant live trees and snags are present.
		Yellow warbler	none noted
		Bald eagle	none noted
		Rocky Mountain elk	none noted
		American marten	none noted
		Mule deer	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
4.7.1	riverine wetlands	Long-toed salamander	Provided that standing bodies of water are present lasting long enough to promote metamorphosis.
		Yellow warbler	none noted
		Bald eagle	none noted
		Rocky Mountain elk	none noted
		American marten	none noted
4.7.2	context	Rocky Mountain elk	none noted
		American marten	
		Mule deer	
4.7.2.1	forest	Rocky Mountain elk	Important for wallows.
		American marten	In Westside forests in Washington, Martens are closely associated with riparian zones, probably because that is where the largest live and dead trees are for den and rest sites.
		Mule deer	Important for fawn rearing.
4.7.2.2	nonforest	Rocky Mountain elk	Particularly in calving season.
		Mule deer	Important for fawn rearing.
4.7.4	marshes	Long-toed salamander	none noted
		Bald eagle	
4.7.5	wet meadows	Long-toed salamander	none noted
		Rocky Mountain elk	
		Mule deer	
4.9	seasonal flooding	Long-toed salamander	Provide hydrology for riparian overflow pools and oxbows, where AMMA breed.
		Bald eagle	none noted
5	**Marine Habitat Elements**	**Bald eagle**	**none noted**
5.1	zone	Bald eagle	none noted
5.1.1	supratidal	Bald eagle	none noted

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
5.1.2	intertidal	Bald eagle	none noted
5.1.3	nearshore subtidal	Bald eagle	none noted
5.8	forms	Bald eagle	none noted
5.8.1	beach	Bald eagle	none noted
5.8.2	off-shore islands/rocks/sea stacks/off-shore cliffs	Bald eagle	none noted
5.8.3	marine cliffs (mainland)	Bald eagle	none noted
5.8.4	delta	Bald eagle	none noted
5.8.6	lagoon	Bald eagle	none noted
5.8.7	salt marsh	Bald eagle	none noted
5.8.9	tidal flat	Bald eagle	none noted
7	**Fire as a Habitat Element**	**Long-toed salamander**	**May have a positive effect, but it needs further study. It is known that it increases the amount of woody debris, especially in juniper forests, and possibly increases water resistance.**
		White-headed woodpecker	**Fire maintains an open pine habitat.**
		Olive-sided flycatcher	**Species is highly associated with post-fire habitats.**
		Mountain quail	**May open habitat.**
		Grasshopper sparrow	**none noted**
		Rocky Mountain elk	**none noted**
		Bighorn sheep	**Hot fires improve sheep habitats.**
		Mule deer	**Generally positive.**
8	**Anthropogenic-related Habitat Elements**	**Boreal owl**	**none noted**
		Yellow warbler	
		Mountain quail	
		Bald eagle	
		Rocky Mountain elk	

Key Environmental Correlates	Description	Focal Species Associated with Habitat Element	Comments on Association
		Bighorn sheep	
		Mule deer	
		Long-toed salamander	
8.1	supplemental boxes, structures and platforms	Boreal owl	Nest boxes.
8.2	roads	Long-toed salamander	Heavily traveled roads have negative effects as barriers and can result in high mortality. This species may use rock roadfill for cover and breeding.
8.8	supplemental food	Mountain quail	Bird feeders.
		Rocky Mountain elk	none noted
		Bighorn sheep	none noted
		Mule deer	none noted
8.9	refuse (includes landfills)	Bald eagle	Landfills, trash dumps.
8.11	guzzlers and waterholes	Long-toed salamander	none noted
		Rocky Mountain elk	
		Mule deer	
8.17	irrigation ditches/canals	Long-toed salamander	none noted
8.18	powerlines/corridors	Yellow warbler	Powerline right-of-ways create shrubby open habitat in forests.
		Mountain quail	Powerline right-of-ways create shrubby open habitat in forests.
		Bald eagle	Positive relationship: perching on powerlines; negative relationship: electrocution hazard.
8.21	mooring piles, dolphins, buoys	Bald eagle	none noted
8.28	hatchery facilities and fish	Bald eagle	none noted

Appendix L. QHA methods used.

Overview (the following overview section was taken from the NPCC website, http://www.nwcouncil.org/fw/subbasinplanning/admin/guides/qha.htm)

The Qualitative Habitat Assessment Model (QHA) was selected for use in the Imnaha subbasin assessment. The QHA provides a structured, “qualitative” approach to analyzing the relationship between a given fish species and its habitat. It does this through a systematic assessment of the condition of several aquatic habitat attributes (sediment, water temperature, etc.) that are thought to be key to biological production and sustainability. Attributes are assessed for each of several stream reaches or small watersheds within a larger hydrologic system. Habitat attribute findings are then considered in terms of their influence on a given species and life stage.

QHA relies on the expert knowledge of natural resource professionals with experience in a given local area to describe physical conditions in the target stream and to create a hypothesis about how the habitat would be used by a given fish species. The hypothesis is the “lens” through which physical conditions in the stream are viewed. The hypothesis consists of weights that are assigned to life stages and habitat attributes, as well as a description of how reaches are used by different life stages. These result in a composite weight that is applied to a physical habitat score in each reach. This score is the difference between a rating of physical habitat in a reach under the current condition and a theoretical “reference” condition.

The ultimate result is an indication of the relative restoration and protection value for each reach and habitat attribute. QHA also provides a means to compare restoration and protection ratings to other biological and demographic information of the user’s choosing. QHA includes features for documenting the decision process and describing the level of confidence that users have in the various ratings.

Reaches

Reaches were delineated for the subbasin using the most recent StreamNet fish distribution layers. An ArcView shape file was created by combining the steelhead, fall chinook, spring/summer chinook, and bull trout fish distributions. This file was summarized to create reach breaks at each change in stream name or fish species use type. Breaking reaches at changes in fish use allowed for easy population of the use tables in the habitat hypothesis portion of the model.

The resulting reach layer was then intersected with the Wallowa-Whitman National Forest 6^{th} field HUCs, so that data generated in the Imnaha Subbasin Multi-Species BA could be used in QHA. The following example explains the rational for the delineation of the four reaches in HUC 07B.

Reach Name	Reach Description
07B Camp Creek 1	Mouth of Camp Creek, upstream 8,794 feet, spring/summer chinook rearing, and steelhead spawning
07B Camp Creek 2	New reach delinieated due to change in fish use, reach continues to be used by steelhead for spawning but StreamNet no longer shows chinook rearing
07B Camp Creek 3	New reach delineated due to change in fish use to steelhead rearing. Reach ended where fish use ends
07B Trail Creek	Only focal fish bearing tributary of Camp Creek in 07B, used by steelhead for spawning. Reach ended where fish use ends

This methodology resulted in the identification of 115 reaches in the Imnaha subbasin. This number falls within the 20–400 guidance suggested by the QHA user's guide.

Associating Current Condition Data from the Imnaha Subbasin Multi-Species BA with the Reaches

The Multi-species Matrix developed for the subwatersheds of the Imnaha subbasin by the Wallowa-Whitman National Forest (Appendix Table 5) has numerous attributes in common with the inputs to QHA. These data were used as inputs to QHA as illustrated in Appendix Table 6. Data from the BA are 6th field HUC scale data, and their application at the reach scale may not be appropriate in all cases. Their inclusion is meant as a starting point to be modified by local experts at the meeting.

Attributes in the BA were rated by subwatershed as "functioning appropriately", "functioning at risk", or "functioning at unacceptable risk". QHA requires users to rate attributes according to the following scale: 0 = < 20% of normative, 1 = 40% of normative, 2 = 60% of normative, 3 = 80% of normative, and 4 = 100% of normative. Subwatersheds with an attribute rated as "functioning appropriately" in the BA were assigned a 3.5 for the corresponding attribute in QHA (Appendix Table 5) for all reaches in that subwatershed. Similarly, subwatersheds with an attribute rated as "functioning at risk" in the BA were assigned a 2.0 in QHA, and subwatersheds with an attribute rated as "functioning at unacceptable risk" in the BA were assigned a 0.5 in QHA for all reaches in that subwatershed.

Appendix Table 5. Current multi-species matrix ratings for subwatersheds of the Imnaha subbasin (USFS 2003d).

Diagnostic or Pathway	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Subpopulation Characteristics within Subpopulation Watersheds			
Subpopulation Size	7Q	All except 7Q	
Growth and Survival		All	
Life History Diversity and Isolation	7Q	All except 7Q	
Persistence and Genetic Integrity	8 and 9—All	7—All	
Water Quality			
Temperature*	7G,7I,7J(St),7L(St),7N, 7Q,7R 8G, 8H,8J,8L 9F,9J,9K,9L,9M,9N,9O,9P	7E,7J(BT)7L(BT),7M,7O,7R(St) 8F(St) 9B(St),9E(St),9I(St),9J(St) 9K(St),9L(BT),9M(BT)	7A,7D,7H,7K,7P, 8A,8B,8C,8D,8E,8F(BT),8K 9A,9B(BT),9C,9D,9E(BT),9G 9H,9I(BT)
Sediment/Substrate	7E,7I,7K,7L,7M,7N,7Q 8A,8H,8K,8L 9B,9C,9D,9I,9J,9L,9M,9N,9O,9P	7D(St),7H,7P,7R 8B,8C,8D,8E,8F,8G,8J 9A,9G, 9H	7A,7D(BT),7J,7O 9E,9F,9K
Chemical Contamin.	All		
Habitat Elements			
Physical Barriers	7—All except 7H, 7I, 7J, 7O, 7P, and 7Q 8—All 9—All except 9J, 9K, 9L, 9M, 9R	7H, 7I, 7O, 7P, and 7Q 9J, 9K, 9L, 9M, 9R	7J
Large Woody Material	7I,7J,7L,7M,7N,7O,7P,7Q,7R 8F,8G,8J,8L 9B,9D,9E,9F,9I,9K,9L,9M 9N,9O,9P	7K 8K 9H,9J	7A,7D,7E,7H 8A,8B,8C,8D,8E,8H 9A,9C,9G
Pool Quality/Freq.		All BT	All St
Off-Channel Habitat	7E,7I,7J,7L,7N,7O,7P,7Q,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9B,9C,9D,9E,9F,9G,9I,9J,9K,9L 9M,9N,9O,9P	7A,7D,7H,7K,7M 8D 9A,9H	
Refugia	7E,7I,7J,7L,7N,7O,7P,7Q,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9B,9C,9D,9E,9F,9G,9I,9J,9K,9L 9M,9N,9O,9P	7A,7D,7H,7K,7M 8D 9A,9H	
Channel Condition and Dynamics			
Width/Depth Ratio	7D,7E,7H,7I,7L,7M,7N,7O,7P,7Q, 7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9A,9B,9C,9D,9E,9F,9G,9I,9K,9L, 9M 9N,9O,9P	7A,7J,7K 8D 9H,9J	
Streambank Condition	7E,7I,7L,7M,7N,7P,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K 9B,9C,9D,9E,9F,9G,9I,9J,9K,9L 9M,9N,9O,9P	7A,7D,7H,7J,7K,7O,7Q 8D,8L 9A,9H,9R	
Floodplain Connectivity	7E,7I,7J,7L,7N,7O,7P,7Q,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9B,9C,9D,9E,9F,9I,9J,9K,9L,9M 9N,9O,9P	7A,7D,7H,7K,7M 8D 9A,9G,9H	

Diagnostic or Pathway	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Watershed Conditions			
Road Density/Drainage Network	7E(St),7H(St),7I,7K,7N(St),7R(St) 8A,8C,8D,8E,8F,8G,8H,8J,8K,8L 9B,9C,9N,9O,9P	7A,7D(St),7E(BT),7H(BT),7L(St),7M,7N(BT),7R(BT) 8B 9A,9D,9G,9H,9J(St)	7D(BT),7J,7L(BT),7O,7P,7Q 9E,9F,9I,9J(BT),9K,9L,9M
Disturbance History/Peak/Base Flows	7E 8A,8B,8C,8F,8G,8H,8J,8K,8L 9B,9C,9G,9H,9I,9J,9L,9M,9N,9O,9P	7A,7D,7H,7I,7J,7K,7L,7M,7N,7O,7P,7Q,7R 8D,8E 9A,9D,9E,9F,9K	
Riparian Habitat Conservation Areas	7I,7L,7N,7R 8A,8B,8C,8E,8F,8G,8H,8J,8K,8L 9B,9C,9G,9I,9J,9L,9M,9N,9O,9P	7A,7D,7E,7H,7J,7K,7M,7O,7P,7Q 8D 9A,9D,9E,9F,9H,9K	
Disturbance Regime	7I,7N,7Q 8-All 9-All	7A,7D,7E,7H,7J,7K,7L,7M,7O,7P,7R	

Appendix Table 6. Relationship between BA and QHA attributes.

Multi-Species BA Attribute	QHA Attribute
Temperature	High Temperature
Sediment/Substrate	Fine Sediment
Chemical Contamin	Pollutants
Physical Barriers	Obstructions
Streambank Condition	Channel Stability
Disturbance History/Peak/Low Flows	High Flows
	Low Flows
Riparian Habitat Conservation Areas	Riparian Condition
Large Woody Material	Habitat Condition (Average scores of 3 [tech team removed Pool quality/freq on September 9, 2003] BA attributes)
Off-Channel Habitat	
Refugia	
No suitable equivalent	Low Temperature
No suitable equivalent	Oxygen

Note the codes in the HUC5 column of the QHA worksheet identify fish use, not 5th field HUC codes.

Reference Condition

The reference condition was set at 4 = 100% of normative for all the attributes and reaches in the subbasin. Any subwatersheds considered to be "functioning appropriately" in the BA had 3.5s assigned to their reaches in QHA. For this reason, no areas of the Imnaha are viewed as pristine in the current QHA model. Many of these reaches may need to have their values adjusted up at the meeting.

Habitat Hypothesis

The Habitat Utilization Hypothesis used in the Imnaha Draft QHA are the same as those used in the Flathead QHA run. They should be reviewed by local experts and evaluated for their applicability in the Imnaha.

The life stage use information was built into the reach delineation and is based on StreamNet GIS data. At the present time, the reference condition and current condition are the same. This situation will need to be evaluated at the meeting.

Habitat score, habitat ranking, and tornado sheets are generated by QHA. Once we refine the model, Ecovista will work with regional QHA experts and local biologists to interpret this information and work it into the Imnaha subbasin plan.

Timeline of incorporation QHA model

9/9

Local biologists edited the draft numbers from the BA. Changes were highlighted in blue.

The review panel filled out missing data values (also highlighted in blue) and filled in habitat hypothesis and reach use data for steelhead and bull trout.

10/28

Experts reviewed steelhead and bull trout worksheets, made slight adjustments. Local biologists modified the steelhead worksheet so it was applicable to fall chinook and spring/summer chinook.

Appendix M. Critical Functional Link Species of the Blue-Mountain Province and their Functions (IBIS 2003).

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
1_1_1_13	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Bark/cambium/bole feeder**	American Beaver	*Castor canadensis*	Open Water—Lakes, Rivers, and Streams
1_1_1_13	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Bark/cambium/bole feeder**	Black Bear	*Ursus americanus*	Alpine Grasslands and Shrublands Westside Grasslands Interior Grasslands
1_1_1_3	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Browser (leaf, stem eater)**	Wild Turkey	*Meleagris gallopavo*	Westside Grasslands
1_1_1_3	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Browser (leaf, stem eater)**	White-tailed Deer (eastside)	*Odocoileus virginianus ochrourus*	Agriculture, Pastures, and Mixed Environs
1_1_1_6	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Sap feeder**	House Finch	*Carpodacus mexicanus*	Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs
1_1_1_7	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Root feeders**	Northern Pocket Gopher	*Thomomys talpoides*	Agriculture, Pastures, and Mixed Environs
1_1_1_7	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Root feeders**	Black Bear	*Ursus americanus*	Westside Grasslands Herbaceous Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
1_1_1_8	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Nectivore (nectar feeder)**	Black-chinned Hummingbird	*Archilochus alexandri*	Shrub-steppe
1_1_1_8	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Nectivore (nectar feeder)**	Rufous Hummingbird	*Selasphorus rufus*	Westside Grasslands
1_1_1_9	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Fungivore (fungus feeder)**	Deer Mouse	*Peromyscus maniculatus*	Urban and Mixed Environs
1_1_2_1_3	Trophic relationships: Heterotrophic consumer Secondary consumer Invertebrate eater **Freshwater or marine zooplankton**	Long-toed Salamander	*Ambystoma macrodactylum*	Upland Aspen Forest Alpine Grasslands and Shrublands Westside Grasslands Montane Coniferous Wetlands
1_1_2_2_1	Trophic relationships: Heterotrophic consumer: Secondary consumer: Vertebrate eater: **Piscivorous (fish eater)**	Raccoon	*Procyon lotor*	Urban and Mixed Environs
1_1_5	Trophic relationships: Heterotrophic consumer: **Cannibalistic**	Black Bear	*Ursus americanus*	Mesic Lowlands Conifer-Hardwood Forest Upland Aspen Forest Alpine Grasslands and Shrublands Westside Grasslands
1_1_6	Trophic relationships: Heterotrophic consumer: **Coprophagous (feeds on fecal material)**	American Pika	*Ochotona princeps*	Alpine Grasslands and Shrublands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
1_1_6	Trophic relationships: Heterotrophic consumer: **Coprophagous (feeds on fecal material)**	Snowshoe Hare	*Lepus americanus*	Mesic Lowlands Conifer-Hardwood Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Montane Coniferous Wetlands
1_1_7	Trophic relationships: Heterotrophic consumer: **Feeds on human garbage/refuse**	Mew Gull	*Larus canus*	Open Water—Lakes, Rivers, and Streams
1_1_7_1	Trophic relationships: Heterotrophic consumer: Feeds on human garbage/refuse: **Aquatic (e.g., offal and bycatch of fishing boats)**	Mew Gull	*Larus canus*	Open Water—Lakes, Rivers, and Streams
3_1	Organismal relationships: **Controls or depresses insect population peaks**	Big Brown Bat	*Eptesicus fuscus*	Urban and Mixed Environs
3_15	Organismal relationships: **Pirates food from other species**	American Crow	*Corvus brachyrhynchos*	Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs
3_16	Organismal relationships: **Interspecific hybridization**	American Crow	*Corvus brachyrhynchos*	Urban and Mixed Environs
3_2	Organismal relationships: **Controls terrestrial vertebrate populations (through predation or displacement)**	Raccoon	*Procyon lotor*	Urban and Mixed Environs
3_3	Organismal relationships: **Pollination vector**	Rufous Hummingbird	*Selasphorus rufus*	Alpine Grasslands and Shrublands Westside Grasslands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_4_1	Organismal relationships: Transportation of viable seeds, spores, plants or animals: **Disperses fungi**	Deer Mouse	*Peromyscus maniculatus*	Westside Grasslands Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs
3_4_4	Organismal relationships: Transportation of viable seeds, spores, plants or animals: **Disperses insects and other invertebrates**	Golden-mantled Ground Squirrel	*Spermophilus lateralis*	Lodgepole Pine Forest and Woodlands Upland Aspen Forest
3_4_6	Organismal relationships: Transportation of viable seeds, spores, plants or animals: **Disperses vascular plants**	Golden-mantled Ground Squirrel	*Spermophilus lateralis*	Upland Aspen Forest
3_5	Organismal relationships: **Creates feeding, roosting, denning, or nesting opportunities for other organisms**	Great Blue Heron	*Ardea herodias*	Open Water—Lakes, Rivers, and Streams
3_5_1	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: **Creates feeding opportunities (other than direct prey relations)**	Great Blue Heron	*Ardea herodias*	Open Water—Lakes, Rivers, and Streams
3_5_1_1	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: Creates feeding opportunities: **Creates sapwells in trees**	Red-breasted Sapsucker	*Sphyrapicus ruber*	Mesic Lowlands Conifer-Hardwood Forest Westside Grasslands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_5_2	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: **Creates roosting, denning, or nesting opportunities**	Great Blue Heron	*Ardea herodias*	Mesic Lowlands Conifer-Hardwood Forest Westside Grasslands Open Water—Lakes, Rivers, and Streams Herbaceous Wetlands Interior Riparian-Wetlands
3_5_2	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: **Creates roosting, denning, or nesting opportunities**	Red Squirrel	*Tamiasciurus hudsonicus*	Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands
3_6_2	Organismal relationships: Primary creation of structures (possibly used by other organisms): **Ground structures**	Bushy-tailed Woodrat	*Neotoma cinerea*	Upland Aspen Forest Shrub-steppe Agriculture, Pastures, and Mixed Environs Montane Coniferous Wetlands Interior Riparian-Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_6_3	Organismal relationships: Primary creation of structures (possibly used by other organisms): **Aquatic structures**	American Beaver	*Castor canadensis*	Mesic Lowlands Conifer-Hardwood Forest Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Montane Coniferous Wetlands
3_7_1	Organismal relationships: User of structures created by other species: **Aerial structures**	Black Tern	*Chlidonias niger*	Open Water—Lakes, Rivers, and Streams
3_7_1	Organismal relationships: User of structures created by other species: **Aerial structures**	Virginia Opossum	*Didelphis virginiana*	Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs
3_7_2	Organismal relationships: User of structures created by other species: **Ground structures**	Deer Mouse	*Peromyscus maniculatus*	Montane Mixed Conifer Forest Upland Aspen Forest Subalpine Parkland Alpine Grasslands and Shrublands Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs Montane Coniferous Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_7_3	Organismal relationships: User of structures created by other species: **Aquatic structures**	Fisher	*Martes pennanti*	Subalpine Parkland
3_7_3	Organismal relationships: User of structures created by other species: **Aquatic structures**	Mink	*Mustela vison*	Lodgepole Pine Forest and Woodlands Upland Aspen Forest Westside Grasslands Interior Grasslands Shrub-steppe
3_8	Organismal relationships: **Nest parasite**	House Finch	*Carpodacus mexicanus*	Urban and Mixed Environs
3_8_1	Organismal relationships: Nest parasite: **Interspecies parasite**	Redhead	*Aythya americana*	Open Water—Lakes, Rivers, and Streams
3_8_1	Organismal relationships: Nest parasite: **Interspecies parasite**	Brown-headed Cowbird	*Molothrus ater*	Mesic Lowlands Conifer-Hardwood Forest Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Westside Grasslands Interior Grasslands Shrub-steppe Agriculture, Pastures, and Mixed Environs Montane Coniferous Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_8_2	Organismal relationships: Nest parasite: **Common interspecific host**	Greater Scaup	*Aythya marila*	Open Water—Lakes, Rivers, and Streams
3_8_2	Organismal relationships: Nest parasite: **Common interspecific host**	House Finch	*Carpodacus mexicanus*	Urban and Mixed Environs
3_9	Organismal relationships: **Primary cavity excavator in snags or live trees**	Black Bear	*Ursus americanus*	Interior Grasslands Herbaceous Wetlands
6_1	Wood structure relationships (either living or dead wood): **Physically fragments down wood**	White-tailed Deer (eastside)	*Odocoileus virginianus ochrourus*	Agriculture, Pastures, and Mixed Environs
6_2	Wood structure relationships (either living or dead wood): **Physically fragments standing wood**	Black Bear	*Ursus americanus*	Alpine Grasslands and Shrublands Herbaceous Wetlands
7_1	Water relationships: **Impounds water by creating diversions or dams**	American Beaver	*Castor canadensis*	Mesic Lowlands Conifer-Hardwood Forest Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Open Water—Lakes, Rivers, and Streams Herbaceous Wetlands Montane Coniferous Wetlands Interior Riparian-Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
7_2	Water relationships: **Creates ponds or wetlands through wallowing**	American Beaver	*Castor canadensis*	Open Water—Lakes, Rivers, and Streams
7_2	Water relationships: **Creates ponds or wetlands through wallowing**	Rocky Mountain Elk	*Cervus elaphus nelsoni*	Alpine Grasslands and Shrublands Interior Grasslands Shrub-steppe
8_1	Vegetation structure and composition relationships: **Creates standing dead trees (snags)**	Black Bear	*Ursus americanus*	Alpine Grasslands and Shrublands Westside Grasslands Interior Grasslands
8_2	Vegetation structure and composition relationships: **Herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)**	Moose	*Alces alces*	Open Water—Lakes, Rivers, and Streams
8_3	Vegetation structure and composition relationships: **Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)**	Canada Goose	*Branta canadensis*	Open Water —Lakes, Rivers, and Streams
8_3	Vegetation structure and composition relationships: **Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)**	Montane Vole	*Microtus montanus*	Agriculture, Pastures, and Mixed Environs
8_3	Vegetation structure and composition relationships:	Rocky Mountain Elk	*Cervus elaphus nelsoni*	Mesic Lowlands Conifer-Hardwood Forest

Appendix N. Regional impacts of out-of-subbasin limiting factors impacting anadromous focal species.

Information on out-of-subbasin effects to aquatic species is taken from the memo by Mobrand Biometrics (2003) describing how these effects were addressed in regional EDT modeling efforts. EDT estimates survival and capacity of a focal species (e.g., spring/summer chinook salmon) within a defined study area (e.g., a subbasin) based on habitat characteristics and combines this with predefined survival rates outside the study area. These predefined survival rates have been termed the "out-of-subbasin effects". These survival rates have been determined only for spring/summer and fall chinook salmon; no rates are available regarding steelhead.

As a contribution to the need to supply subbasin planners with a set of assumptions regarding the out-of-subbasin effects, Mobrand Biometrics (2003) provided the assumptions that are currently incorporated in the Ecosystem Diagnosis and Treatment model that is being used by subbasin planners. These assumptions in EDT about out-of-subbasin effects were developed as part of the NPCC's Multi-species Framework Project. Calculations behind the results provided here were documented in the final project report to the NPCC from Mobrand Biometrics and in Marcot et al. (2002). The framework assumptions were intended to capture conditions prevailing in the region around the year 2000. The current assumptions in EDT about out-of-subbasin effects are based on passage and hydrologic modeling done by the NPCC, NMFS, and other participants in the Framework Project.

The out-of-subbasin effects are defined by Mobrand Biometrics (2003) as the total survival rate of juvenile fish from the mouth of the subbasin to their return to the subbasin as adults. Out-of-subbasin effects account for survival conditions through the hydropower system, the Columbia River below Bonneville Dam, the estuary, the ocean, and any harvest occurring outside the subbasin. To be specific, out-of-subbasin effects equals survival through the hydropower system times survival in the lower Columbia River times survival through the estuary times survival in the ocean times overall harvest rate. This definition of the out-of-subbasin effects makes it equivalent to the smolt-to-adult survival rate or SAR that has been used in other modeling efforts. The SAR is specific for a species and is related to the position of the subbasin within the Columbia Basin and especially relative to its position within the hydropower system. In other words, because the SAR (out-of-subbasin effects) is affected by survival through the hydropower system (see the equation above), the SAR is affected by the number of dams that fish must traverse to get to and from the subbasin. As a result, we see SARs generally decline going upstream through the Columbia Basin.

Because the out-of-subbasin assumptions reduce to the SARs that result from the model, Mobrand Biometrics (2003) represents the combined effect of all current assumptions in EDT about out-of-subbasin effects as the SARs for spring/summer and fall chinook salmon projected from various points in the Columbia Basin (Appendix Table 7). These SARs include all considerations for dam passage, survival below Bonneville Dam, survival through the Columbia estuary and the ocean and assumed harvest outside the subbasin. The hope is that by focusing on the SARs (which can be related to empirical survival estimates), the region can avoid becoming embroiled in debates over details of individual survival components as part of the subbasin planning process. This is consistent with direction provided by the NPCC in previous reports on the issue of out-of-subbasin effects.

The results in Appendix Table 7 are provided to clarify the assumptions that are available to subbasin planners regarding the SARs in EDT. SAR has been estimated from empirical data in a few subbasins in the PATH process and elsewhere. Mobrand Biometrics has compared the estimated SARs in EDT to available empirical estimates of SARs and find them generally in agreement.

Appendix Table 7. Smolt-to-adult survival rates (SAR) for spring/summer and fall chinook currently used in the Ecosystem Diagnosis and Treatment model.

	Spring Chinook		***Fall Chinook migrants***	
	SAR	**Expl. Rate**	**SAR**	**Expl. Rate**
Lower Granite Pool	0.9%	6.8%	0.4%	45%
Little Goose Pool	1.0%		0.4%	
Lower Monumental Pool	1.1%		0.5%	
Ice Harbor Pool	1.3%		0.6%	
Lower Snake	1.4%		0.8%	
McNary Pool	1.4%	6.8%	0.7%	45%
John Day Pool	1.5%		0.8%	
The Dalles Pool	2.0%		0.9%	
Bonneville Pool	2.2%		1.0%	
Lower Columbia	3.1%		1.4%	
Wells Pool	0.7%	6.8%	0.3%	45%
Rock Island Pool	0.9%		0.4%	
Wanapum Pool	1.1%		0.4%	
Priest Rapids Pool	1.2%		0.6%	
Hanford Reach	1.4%		0.8%	

The results in Appendix Table 7 approximate the survival rates that would be applied to spring/summer and fall chinook entering the Columbia River or Snake River at the points in the table. For example, spring/summer chinook entering the Snake River at the head of Lower Granite pool (from the Imnaha subbasin) would be subject to a SAR of 0.9% in EDT. This SAR incorporates an assumed harvest on spring/summer chinook of 6.8%. Fall chinook from the Imnaha subbasin would be subject to a SAR of 0.4% in EDT. This SAR incorporates an assumed harvest on spring/summer chinook of 45%. The SARs for fall chinook represent survival of actively migrating juveniles. Because fall chinook also include a component of fish that rear for some period within the mainstem Columbia and Snake rivers, total survival of fall chinook from each point may differ from the results in Appendix Table 7.

The SARs in Appendix Table 7 represent survival under “typical” conditions in the Columbia River and the ocean. Empirical estimates of SAR that have been reported in the PATH process and elsewhere vary widely between years reflecting environmental variation including regime shifts in ocean survival conditions. However, the EDT assessment is intended to characterize the potential of current habitat in a subbasin with respect to a focal species and does not include environmental variability.

Appendix Table 8 and Appendix Table 10 provide the schedule of survival rates at each dam for each month of the year for spring/summer and fall chinook salmon. In EDT, fish leave the subbasin and enter the mainstem across a range of months. They move down at travel speeds related to flow, encountering daily survival rates in the reservoirs. Fish are then passed through a dam where they encounter the survival rates in the tables below. A portion of the fish may be transported downstream. The dam survival rates below were calculated using NMFS's SimPass model with conditions specified in the Biological Opinion prevailing in 2000. Other mainstem passage survival assumptions are described in Marcot et al. (2002).

Appendix Table 8. Yearling (spring/summer) chinook dam survival rates currently used in EDT (Marcot et al. 2002).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Granite	0.9	0.9	0.93	0.98	0.98	0.98	0.95	0.95	0.95	0.95	0.9	0.9
Little Goose	0.9	0.9	0.93	0.98	0.98	0.98	0.95	0.95	0.95	0.95	0.9	0.9
Lower Monumental	0.9	0.9	0.93	0.96	0.96	0.96	0.94	0.94	0.94	0.94	0.9	0.9
Ice Harbor	0.9	0.9	0.94	0.97	0.97	0.97	0.97	0.97	0.95	0.95	0.9	0.9
McNary	0.9	0.9	0.94	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97
John Day	0.9	0.9	0.93	0.96	0.96	0.96	0.96	0.96	0.94	0.94	0.9	0.9
The Dalles	0.9	0.9	0.94	0.98	0.98	0.98	0.98	0.98	0.9	0.9	0.9	0.9
Bonneville	0.9	0.9	0.92	0.95	0.95	0.95	0.95	0.95	0.93	0.93	0.9	0.9
Rocky Reach	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Rock Island	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Wanapum	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Priest Rapids	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Wells	0.9	0.9	0.9	0.97	0.97	0.97	0.97	0.97	0.89	0.89	0.89	0.89

Appendix Table 9. Subyearling (fall) chinook dam survival rates currently used in EDT (Marcot et al. 2002).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Granite	0.9	0.9	0.95	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.9	0.9
Little Goose	0.9	0.9	0.94	0.96	0.96	0.96	0.94	0.94	0.94	0.94	0.9	0.9
Lower Monumental	0.9	0.9	0.94	0.95	0.95	0.95	0.95	0.94	0.94	0.93	0.9	0.9
Ice Harbor	0.9	0.9	0.93	0.96	0.96	0.96	0.96	0.96	0.94	0.94	0.9	0.9
McNary	0.9	0.9	0.96	0.98	0.98	0.98	0.98	0.98	0.95	0.95	0.95	0.95
John Day	0.9	0.9	0.95	0.97	0.97	0.97	0.97	0.97	0.95	0.95	0.9	0.9
The Dalles	0.9	0.9	0.93	0.98	0.98	0.98	0.98	0.98	0.9	0.9	0.9	0.9
Bonneville	0.9	0.9	0.91	0.93	0.93	0.93	0.93	0.93	0.91	0.91	0.9	0.9
Rocky Reach	0.89	0.89	0.91	0.93	0.93	0.93	0.93	0.93	0.89	0.89	0.89	0.89
Rock Island	0.89	0.89	0.9	0.93	0.93	0.93	0.93	0.93	0.89	0.89	0.89	0.89
Wanapum	0.89	0.89	0.91	0.92	0.92	0.92	0.92	0.92	0.89	0.89	0.89	0.89
Priest Rapids	0.89	0.89	0.9	0.92	0.92	0.92	0.92	0.92	0.89	0.89	0.89	0.89
Wells	0.89	0.89	0.94	0.97	0.97	0.97	0.97	0.97	0.89	0.89	0.89	0.89

Appendix O. Raw data and results of the qualitative habitat assessment (QHA) model

Various input and output information from the QHA model is presented to provide transparency regarding data inputs, and allow readers the opportunity to consider possible alternative interpretations of outputs. All data inputs represent professional judgments since no suitable and timely method could be developed for defensibly transforming real habitat data into categorical classifications used by the QHA model. Regional biologists within the ODFW, NPT, USFS, NOAA Fisheries, and USFWS, who were most familiar with habitat conditions within the various sixth field HUCs verified the data used in the model. No changes were requested or made to original data inputs based on technical team review.

The following information is presented by focal species (*e.g.,* spring/summer chinook salmon, fall chinook, summer steelhead, bull trout) in this appendix:

Model Inputs:

1. Existing conditions
2. Reference conditions
3. Species habitat hypotheses
4. Species range

Model Outputs:

1. Habitat scores
2. Habitat ranks

Readers interested in detailed explanation of the QHA model development and function are referred to the QHA Users Guide (Mobrand Biometrics 2003). The following scoring/ranking system is applicable to reference and current habitat scoring used throughout the QHA model.

Scoring	
Confidence Rating	Attribute Rating
0 = Unknown	0 = 0% of normative
1 = Expert Opinion	1 = 25% of normative
2 = Well Documented	2 = 50% of normative
	3 = 75% of normative
	4 = 100% of normative

Existing Conditions – Spring/summer chinook

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	2.0	2.0	1.5	1.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
07B Camp Creek 1	2.5	2.5	2.0	2.0	2.0	1.5	4.0	4.0	2.5	4.0	2.0
07D Little Sheep Creek 1	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
07E Bear Gulch	2.0	3.5	2.5	3.5	3.5	3.5	4.0	4.0	2.0	3.5	3.5
07K Big Sheep Creek 1	2.0	2.0	2.0	3.5	2.0	2.0	4.0	4.0	0.5	3.5	3.5
07M Big Sheep Creek	2.0	3.5	2.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5	3.5
07P Big Sheep Creek 3	2.0	3.5	3.5	2.0	2.0	2.0	4.0	4.0	2.0	3.5	2.0
07Q Lick Creek 1	2.0	2.0	3.5	3.5	2.0	2.0	4.0	4.0	3.5	3.5	2.0
07R Big Sheep Creek Headwaters	3.0	3.0	3.5	2.5	2.0	2.0	4.0	4.0	3.5	3.5	3.0
08A Imnaha River	3.5	3.5	2.5	3.5	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08B Imnaha River	2.5	3.5	2.5	2.0	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08C Imnaha River 2	3.5	3.5	2.5	2.0	2.8	2.8	4.0	4.0	0.5	3.5	3.5
08D Imnaha River 3 (town)	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
08E Horse Creek	3.5	3.5	2.5	2.0	2.0	2.0	4.0	4.0	2.0	3.5	3.5
08H Lightning Creek	3.5	3.5	2.5	3.5	2.0	3.5	4.0	4.0	3.5	3.5	3.5
08K Cow Creek	3.5	3.5	3.0	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09A Imnaha River	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
09B Freezeout Creek 1	3.5	3.5	3.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09C Imnaha River	3.5	3.5	2.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09D Grouse Creek 1	2.0	3.5	3.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5	1.0
09G Imnaha River 6	3.5	3.5	2.5	2.0	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09H Summit Creek 1	2.0	2.0	2.0	2.0	2.0	2.0	4.0	4.0	2.0	3.5	3.5
09I Crazyman Creek 1	3.5	3.5	3.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09J Imnaha River	3.5	3.5	3.0	3.5	2.0	3.5	4.0	4.0	2.0	3.5	2.0
09L Imnaha River	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09M Imnaha River	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	4.0
09N Imnaha River	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09P South Fork Imnaha River 1	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	4.0

Reference Conditions – Spring/summer chinook

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07B Camp Creek 1	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
07D L. Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07E Bear Gulch	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07K Big Sheep Creek 1	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	4.0
07M Big Sheep Creek	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	4.0
07P Big Sheep Creek 3	3.0	4.0	4.0	3.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0
07Q Lick Creek 1	3.0	3.0	4.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	3.0
07R Big Sheep Creek Headwaters	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08A Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08B Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08C Imnaha River 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08D Imnaha River 3 (town)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08E Horse Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08H Lightning Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
08K Cow Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09A Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09B Freezeout Creek 1	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09C Imnaha River	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09D Grouse Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09G Imnaha River 6	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09H Summit Creek 1	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09I Crazyman Creek 1	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09J Imnaha River	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09L Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09M Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09N Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09P South Fork Imnaha River 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0

Species Habitat Hypothesis – Spring/summer chinook

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Life Stage Rank (1-4)	4.0	3.0	3.0	2.0
Assign a weight to each attribute (0-2) relative to its importance to the life stage				
Riparian Condition	1.0	2.0	2.0	0.5
Channel stability	2.0	2.0	2.0	0.5
Habitat Diversity	1.5	2.0	2.0	0.5
Fine sediment	2.0	2.0	2.0	0.5
High Flow	2.0	1.0	1.0	1.0
Low Flow	2.0	2.0	2.0	2.0
Oxygen	2.0	2.0	2.0	2.0
Low Temp	0.5	0.5	0.5	0.0
High Temp	2.0	2.0	2.0	2.0
Pollutants	2.0	2.0	1.0	1.0
Obstructions	1.0	1.0	1.0	2.0

Species Range – Spring/summer chinook

Assign a weight to each attribute (0-2) relative to the reach's importance to the life stage

Reach Name	Current Range (0-4) Spawn and incubation	Current Range (0-4) Summer rearing	Current Range (0-4) Winter rearing	Current Range (0-4) Migration	Reference Range (0-4) Spawn and incubation	Reference Range (0-4) Summer rearing	Reference Range (0-4) Winter rearing	Reference Range (0-4) Migration
07A Big Sheep Creek	0.0	1.0	1.0	2.0	0.0	1.0	1.0	2.0
07B Camp Creek 1	0.0	2.0	1.0	2.0	0.0	2.0	1.0	2.0
07D Little Sheep Creek 1	0.0	2.0	0.5	2.0	0.0	2.0	1.0	2.0
07E Bear Gulch	0.0	0.5	0.0	0.0	0.0	1.0	0.0	0.0
07K Big Sheep Creek 1	1.0	1.0	0.5	2.0	2.0	2.0	1.0	2.0
07M Big Sheep Creek	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0
07P Big Sheep Creek 3	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0
07Q Lick Creek 1	1.0	1.0	1.0	2.0	2.0	2.0	1.5	2.0
07R Big Sheep Creek Headwaters	1.0	1.7	0.5	1.0	1.5	2.0	1.0	1.0
08A Imnaha River	0.0	1.0	1.0	2.0	0.0	1.0	1.0	2.0
08B Imnaha River	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
08C Imnaha River 2	0.0	1.0	0.5	2.0	0.0	1.5	1.0	2.0
08D Imnaha River 3 (town)	0.0	1.0	1.0	2.0	0.0	1.5	1.5	2.0
08E Horse Creek	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
08H Lightning Creek	0.0	1.0	0.5	2.0	0.0	2.0	1.0	2.0
08K Cow Creek	0.0	1.0	0.5	2.0	0.0	2.0	1.0	2.0
09A Imnaha River	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
09B Freezeout Creek 1	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
09C Imnaha River	0.0	1.0	0.5	2.0	0.0	1.0	1.0	2.0
09D Grouse Creek 1	0.5	2.0	1.0	1.0	2.0	2.0	2.0	2.0
09G Imnaha River 6	2.0	2.0	0.8	2.0	2.0	2.0	1.0	2.0
09H Summit Creek 1	0.0	1.0	0.5	2.0	0.0	1.0	0.5	2.0
09I Crazyman Creek 1	0.0	1.0	0.5	2.0	0.0	1.0	0.5	2.0
09J Imnaha River	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0
09L Imnaha River	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0
09M Imnaha River	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0
09N Imnaha River	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0
09P South Fork Imnaha River 1	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0

Habitat Scores – Spring/summer chinook

Reach Name	Reach Score (yellow)	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Score (green)	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	**-0.15**	-0.15	-0.15	-0.11	-0.07	-0.10	-0.21	0.00	0.00	-0.05	-0.24	-0.26	**0.16**	0.15	0.15	0.18	0.22	0.10	0.21	0.00	0.00	0.36	0.03	0.04
07B Camp Creek 1	**-0.24**	-0.26	-0.26	-0.21	-0.21	-0.14	-0.20	0.00	0.00	-0.34	-0.40	-0.18	**0.17**	0.16	0.16	0.21	0.21	0.07	0.34	0.00	0.00	0.20	0.00	0.18
07D Little Sheep Creek 1	**-0.19**	-0.18	-0.18	-0.13	-0.18	-0.12	-0.24	0.00	0.00	-0.06	-0.32	-0.28	**0.21**	0.21	0.21	0.26	0.21	0.14	0.27	0.00	0.00	0.47	0.05	0.04
07E Bear Gulch	**-0.04**	-0.03	-0.05	-0.04	-0.05	-0.03	-0.05	0.00	0.00	-0.03	-0.05	-0.03	**0.03**	0.06	0.02	0.05	0.02	0.01	0.02	0.00	0.00	0.06	0.02	0.01
07K Big Sheep Creek 1	**-0.23**	-0.16	-0.20	-0.18	-0.35	-0.17	-0.26	0.00	0.00	-0.07	-0.36	-0.30	**0.19**	0.15	0.19	0.17	0.09	0.15	0.22	0.00	0.00	0.55	0.09	0.07
07M Big Sheep Creek	**-0.30**	-0.19	-0.40	-0.26	-0.40	-0.19	-0.29	0.00	0.00	-0.29	-0.38	-0.33	**0.15**	0.18	0.11	0.10	0.11	0.17	0.25	0.00	0.00	0.25	0.10	0.07
07P Big Sheep Creek 3	**-0.28**	-0.19	-0.40	-0.36	-0.23	-0.19	-0.29	0.00	0.00	-0.29	-0.38	-0.19	**0.17**	0.18	0.11	0.10	0.22	0.17	0.25	0.00	0.00	0.25	0.10	0.15
07Q Lick Creek 1	**-0.30**	-0.19	-0.23	-0.36	-0.40	-0.19	-0.29	0.00	0.00	-0.51	-0.38	-0.19	**0.14**	0.16	0.20	0.09	0.10	0.16	0.23	0.00	0.00	0.12	0.10	0.14
07R Big Sheep Creek Headwaters	**-0.31**	-0.28	-0.34	-0.36	-0.29	-0.17	-0.26	0.00	0.00	-0.46	-0.39	-0.23	**0.16**	0.13	0.16	0.07	0.24	0.24	0.35	0.00	0.00	0.09	0.08	0.10
08A Imnaha River	**-0.22**	-0.26	-0.26	-0.18	-0.26	-0.18	-0.31	0.00	0.00	-0.05	-0.24	-0.26	**0.09**	0.04	0.04	0.11	0.04	0.03	0.10	0.00	0.00	0.36	0.03	0.04
08B Imnaha River	**-0.17**	-0.14	-0.20	-0.14	-0.11	-0.15	-0.27	0.00	0.00	-0.04	-0.21	-0.23	**0.11**	0.11	0.04	0.11	0.15	0.03	0.10	0.00	0.00	0.36	0.03	0.04
08C Imnaha River 2	**-0.17**	-0.20	-0.20	-0.14	-0.11	-0.12	-0.24	0.00	0.00	-0.04	-0.21	-0.23	**0.12**	0.04	0.04	0.13	0.18	0.07	0.15	0.00	0.00	0.42	0.04	0.04
08D Imnaha River 3 (town)	**-0.16**	-0.15	-0.15	-0.11	-0.15	-0.10	-0.21	0.00	0.00	-0.05	-0.24	-0.26	**0.21**	0.21	0.21	0.26	0.21	0.14	0.27	0.00	0.00	0.47	0.05	0.04
08E Horse Creek	**-0.17**	-0.20	-0.20	-0.14	-0.11	-0.09	-0.18	0.00	0.00	-0.18	-0.21	-0.23	**0.10**	0.04	0.04	0.11	0.15	0.10	0.21	0.00	0.00	0.21	0.03	0.04
08H Lightning Creek	**-0.21**	-0.20	-0.20	-0.14	-0.20	-0.09	-0.31	0.00	0.00	-0.31	-0.21	-0.23	**0.07**	0.05	0.05	0.16	0.05	0.07	0.07	0.00	0.00	0.07	0.05	0.04

Reach Name	Reach Score (yellow)	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Score (green)	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
08K Cow Creek	**-0.20**	-0.20	-0.20	-0.17	-0.20	-0.09	-0.31	0.00	0.00	-0.18	-0.21	-0.23	**0.08**	0.05	0.05	0.10	0.05	0.07	0.07	0.00	0.00	0.27	0.05	0.04
09A Imnaha River	**-0.13**	-0.11	-0.11	-0.09	-0.11	-0.09	-0.18	0.00	0.00	-0.04	-0.21	-0.23	**0.15**	0.15	0.15	0.18	0.15	0.10	0.21	0.00	0.00	0.36	0.03	0.04
09B Freezeout Creek 1	**-0.20**	-0.20	-0.20	-0.20	-0.20	-0.09	-0.31	0.00	0.00	-0.18	-0.21	-0.23	**0.06**	0.04	0.04	0.04	0.04	0.05	0.05	0.00	0.00	0.21	0.03	0.04
09C Imnaha River	**-0.20**	-0.20	-0.20	-0.14	-0.20	-0.09	-0.31	0.00	0.00	-0.18	-0.21	-0.23	**0.07**	0.04	0.04	0.11	0.04	0.05	0.05	0.00	0.00	0.21	0.03	0.04
09D Grouse Creek 1	**-0.29**	-0.22	-0.42	-0.40	-0.42	-0.16	-0.27	0.00	0.00	-0.27	-0.38	-0.08	**0.28**	0.35	0.11	0.10	0.11	0.33	0.50	0.00	0.00	0.50	0.10	0.44
09G Imnaha River 6	**-0.49**	-0.48	-0.63	-0.40	-0.36	-0.29	-0.74	0.00	0.00	-0.42	-0.62	-0.44	**0.18**	0.07	0.09	0.25	0.38	0.15	0.11	0.00	0.00	0.44	0.09	0.07
09H Summit Creek 1	**-0.15**	-0.11	-0.11	-0.11	-0.11	-0.09	-0.18	0.00	0.00	-0.18	-0.21	-0.23	**0.10**	0.11	0.11	0.11	0.11	0.04	0.18	0.00	0.00	0.18	0.03	0.03
09I Crazyman Creek 1	**-0.20**	-0.20	-0.20	-0.20	-0.20	-0.09	-0.31	0.00	0.00	-0.18	-0.21	-0.23	**0.05**	0.03	0.03	0.03	0.03	0.04	0.04	0.00	0.00	0.18	0.03	0.03
09J Imnaha River	**-0.53**	-0.51	-0.66	-0.50	-0.66	-0.30	-0.77	0.00	0.00	-0.44	-0.64	-0.26	**0.16**	0.07	0.09	0.17	0.09	0.15	0.11	0.00	0.00	0.44	0.09	0.26
09L Imnaha River	**-0.63**	-0.51	-0.66	-0.58	-0.66	-0.53	-0.77	0.00	0.00	-0.77	-0.73	-0.46	**0.08**	0.07	0.09	0.08	0.09	0.08	0.11	0.00	0.00	0.11	0.00	0.07
09M Imnaha River	**-0.64**	-0.51	-0.66	-0.58	-0.66	-0.53	-0.77	0.00	0.00	-0.77	-0.73	-0.52	**0.07**	0.07	0.09	0.08	0.09	0.08	0.11	0.00	0.00	0.11	0.00	0.00
09N Imnaha River	**-0.63**	-0.51	-0.66	-0.58	-0.66	-0.53	-0.77	0.00	0.00	-0.77	-0.73	-0.46	**0.08**	0.07	0.09	0.08	0.09	0.08	0.11	0.00	0.00	0.11	0.00	0.07
09P South Fork Imnaha River 1	**-0.64**	-0.51	-0.66	-0.58	-0.66	-0.53	-0.77	0.00	0.00	-0.77	-0.73	-0.52	**0.06**	0.07	0.09	0.08	0.09	0.08	0.11	0.00	0.00	0.11	0.00	-0.13

Habitat Ranks – Spring/summer chinook

Reach Name	Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions		Reach Rank	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	26	4	4	6	8	7	3	10	10	9	2	1		10	5	5	4	2	7	3	10	10	1	9	8
07B Camp Creek 1	12	3	3	5	5	9	7	10	10	2	1	8		6	6	6	2	2	8	1	9	9	4	9	5
07D Little Sheep Creek 1	20	4	4	7	4	8	3	10	10	9	1	2		2	4	4	3	4	7	2	10	10	1	8	9
07E Bear Gulch	28	6	1	5	1	8	1	10	10	6	1	8		28	1	4	3	4	8	4	10	10	1	4	8
07K Big Sheep Creek 1	13	8	5	6	2	7	4	10	10	9	1	3		4	6	3	4	7	5	2	10	10	1	8	9
07M Big Sheep Creek	9	8	1	7	1	8	5	10	10	5	3	4		12	3	5	7	5	4	1	10	10	1	7	9
07P Big Sheep Creek 3	11	7	1	3	6	7	4	10	10	4	2	7		6	4	7	8	3	5	1	10	10	1	8	6
07Q Lick Creek 1	8	7	6	4	2	7	5	10	10	1	3	7		13	3	2	9	7	4	1	10	10	6	8	5
07R Big Sheep Creek Headwaters	7	6	4	3	5	9	7	10	10	1	2	8		9	5	4	9	2	3	1	10	10	7	8	6
08A Imnaha River	14	2	2	7	2	7	1	10	10	9	6	2		18	4	4	2	4	9	3	10	10	1	8	4
08B Imnaha River	23	6	4	6	8	5	1	10	10	9	3	2		15	3	6	3	2	9	5	10	10	1	8	6

Reach Name	Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Rank (2)	Riparian Condition (2)	Channel form	Channel complexity	Fine sediment (2)	High Flow (2)	Low Flow (2)	Oxygen (2)	Low Temperature (2)	High Temperature (2)	Pollutants (2)	Obstructions (2)
08C Imnaha River 2	**22**	4	4	6	8	7	1	10	10	9	3	2	**14**	6	6	4	2	5	3	10	10	1	8	9
08D Imnaha River 3 (town)	**24**	4	4	7	4	8	3	10	10	9	2	1	**3**	4	4	3	4	7	2	10	10	1	8	9
08E Horse Creek	**21**	3	3	7	8	9	5	10	10	5	2	1	**16**	6	6	4	3	5	1	10	10	1	9	6
08H Lightning Creek	**15**	5	5	8	5	9	1	10	10	1	4	3	**23**	5	5	1	5	2	2	10	10	2	8	9
08K Cow Creek	**18**	4	4	8	4	9	1	10	10	7	3	2	**19**	5	5	2	5	3	3	10	10	1	8	9
09A Imnaha River	**27**	4	4	8	4	7	3	10	10	9	2	1	**11**	4	4	3	4	7	2	10	10	1	9	8
09B Freezeout Creek 1	**16**	4	4	4	4	9	1	10	10	8	3	2	**25**	4	4	4	4	2	2	10	10	1	9	4
09C Imnaha River	**19**	4	4	8	4	9	1	10	10	7	3	2	**24**	5	5	2	5	3	3	10	10	1	9	5
09D Grouse Creek 1	**10**	7	1	3	1	8	5	10	10	5	4	9	**1**	4	6	8	6	5	1	10	10	1	8	3
09G Imnaha River 6	**6**	4	2	7	8	9	1	10	10	6	3	5	**5**	8	6	3	2	4	5	10	10	1	7	9
09H Summit Creek 1	**25**	5	5	5	5	9	3	10	10	3	2	1	**16**	3	3	3	3	7	1	10	10	1	9	8
09I Crazyman Creek 1	**16**	4	4	4	4	9	1	10	10	8	3	2	**27**	6	6	6	6	2	2	10	10	1	5	4
09J Imnaha	**5**	5	2	6	2	8	1	10	10	7	4	9	**8**	9	6	3	6	4	5	10	10	1	8	2

Reach Name	Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
River												
09L Imnaha River	3	8	4	6	4	7	1	10	10	1	3	9
09M Imnaha River	1	9	4	6	4	7	1	10	10	1	3	8
09N Imnaha River	3	8	4	6	4	7	1	10	10	1	3	9
09P South Fork Imnaha River 1	1	9	4	6	4	7	1	10	10	1	3	8

Reach Name	Reach Rank	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
River												
09L Imnaha River	20	7	3	5	3	6	1	9	9	1	9	8
09M Imnaha River	22	7	3	5	3	6	1	8	8	1	8	8
09N Imnaha River	20	7	3	5	3	6	1	9	9	1	9	8
09P South Fork Imnaha River 1	26	7	3	5	3	6	1	8	8	1	8	11

Existing Conditions – Fall Chinook

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
08A Imnaha River	3.5	3.5	2.5	3.5	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08B Imnaha River	2.5	3.5	2.5	2.0	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08C Imnaha River 2	3.5	3.5	2.5	2.0	2.8	2.8	4.0	4.0	0.5	3.5	3.5
08D Imnaha River 3 (town)	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5

Reference Conditions – Fall Chinook

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
08A Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08B Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08C Imnaha River 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08D Imnaha River 3 (town)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Species Habitat Hypothesis – Fall Chinook

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Life Stage Rank (1-4)	4.0	3.0	3.0	3.0

Assign a weight to each attribute (0-2) relative to its importance to the life stage

Riparian Condition	0.5	1.0	1.0	0.5
Channel stability	2.0	1.0	1.0	0.5
Habitat Diversity	1.0	2.0	2.0	0.5
Fine sediment	2.0	2.0	2.0	0.5
High Flow	2.0	1.5	1.5	1.5
Low Flow	2.0	2.0	2.0	2.0
Oxygen	2.0	2.0	2.0	2.0
Low Temp	1.0	0.0	0.0	0.0
High Temp	0.5	0.5	0.5	0.5
Pollutants	2.0	2.0	2.0	2.0
Obstructions	0.0	1.0	1.0	2.0

Species Range – Fall Chinook

	Current Range (0-4)				Reference Range (0-4)			
Reach Name	Spawn and incubation	Summer rearing	Winter rearing	Migration	Spawn and incubation	Summer rearing	Winter rearing	Migration
08A Imnaha River	2.0	1.5	1.5	2.0	2.0	1.5	1.5	2.0
08B Imnaha River	2.0	1.5	1.5	2.0	2.0	1.5	1.5	2.0
08C Imnaha River 2	2.0	1.5	1.5	2.0	2.0	1.5	1.5	2.0
08D Imnaha River 3 (town)	2.0	1.5	1.5	2.0	2.0	1.5	1.5	2.0

Habitat Scores – Fall Chinook

	Protection Scores												Restoration Scores											
Reach Name	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
08A Imnaha River	**-0.52**	-0.30	-0.53	-0.39	-0.70	-0.73	-0.75	0.00	0.00	-0.03	-0.88	-0.40	**0.13**	0.04	0.08	0.24	0.10	0.10	0.25	0.00	0.00	0.22	0.13	0.06
08B Imnaha River	**-0.48**	-0.22	-0.53	-0.39	-0.40	-0.73	-0.75	0.00	0.00	-0.03	-0.88	-0.40	**0.18**	0.13	0.08	0.24	0.40	0.10	0.25	0.00	0.00	0.22	0.13	0.06
08C Imnaha River 2	**-0.47**	-0.30	-0.53	-0.39	-0.40	-0.58	-0.69	0.00	0.00	-0.03	-0.88	-0.40	**0.19**	0.04	0.08	0.24	0.40	0.26	0.31	0.00	0.00	0.22	0.13	0.06
08D Imnaha River 3 (town)	**-0.37**	-0.17	-0.30	-0.24	-0.40	-0.42	-0.50	0.00	0.00	-0.03	-0.88	-0.40	**0.29**	0.17	0.30	0.39	0.40	0.42	0.50	0.00	0.00	0.22	0.13	0.06

Habitat Ranks – Fall Chinook

Reach Name	Protection Ranks													Restoration Ranks											
	Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions		Reach Rank	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
08A Imnaha River	1	8	5	7	4	3	2	10	10	9	1	6		4	9	7	2	6	5	1	10	10	3	4	8
08B Imnaha River	2	8	4	7	5	3	2	10	10	9	1	6		3	5	8	3	1	7	2	10	10	4	6	9
08C Imnaha River 2	3	8	4	7	5	3	2	10	10	9	1	6		2	9	7	4	1	3	2	10	10	5	6	8
08D Imnaha River 3 (town)	4	8	6	7	4	3	2	10	10	9	1	5		1	7	5	4	3	2	1	10	10	6	8	9

Existing Conditions – Summer steelhead

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek Mouth	2.0	2.0	1.5	1.0	2.0	2.0	4.0		0.5	3.5	3.5
07B Lower Camp Creek	2.5	2.3	2.5	2.3	2.0	2.4	4.0	4.0	2.5	4.0	2.8
07C Upper Camp Creek	2.0	2.3	2.0	2.0	2.0	2.7	4.0	4.0	2.0	4.0	3.0
07D Little Sheep Creek 1	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
07E Summit Creek (Bear&DowneyGulch)	2.0	3.2	2.5	2.0	3.5	3.5	4.0	4.0	2.0	3.5	3.2
07F Devils Gulch	3.0	3.0	3.0	2.5	2.0	3.5	4.0	4.0	3.0	3.0	3.5
07G Lightning Creek	2.0	2.0	2.0	2.0	2.0	2.5	4.0	3.5	2.0	2.5	2.0
07H Little Sheep Creek 2	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	2.0
07I McCully Creek	3.5	3.5	3.5	3.5	2.0	2.0	4.0	4.0	3.5	3.5	2.0
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	2.0	2.0	3.5	0.5	2.0	2.0	4.0	4.0	3.5	3.5	0.5
07K Big Sheep Creek 1	2.0	2.0	2.0	3.5	2.0	2.0	4.0	4.0	0.5	3.5	3.5
07L Squaw Creek	3.0	3.5	3.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5	3.5
07M Big Sheep Creek 2	2.0	3.5	2.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5	3.5
07N Marr Creek	3.0	3.5	3.5	3.5	2.0	2.0	4.0	4.0	2.0	3.5	3.5
07O Carrol Creek	2.0	2.0	3.5	0.5	2.0	2.0	4.0	4.0	2.0	3.5	2.0
07P Big Sheep Creek 3	2.0	3.5	3.5	2.0	2.0	2.0	4.0	4.0	2.0	3.5	2.0
07Q Lick Creek	2.0	2.0	3.5	3.5	2.0	2.0	4.0	4.0	3.5	3.5	2.0
07R Big/Little Sheep	3.3	3.3	3.5	2.2	2.0	2.0	4.0	4.0	3.5	3.5	3.3

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
Headwaters											
08A Imnaha River Confluence	3.5	3.5	2.5	3.5	3.5	3.0	4.0	4.0	0.5	3.5	3.5
08B Imnaha River 1	2.7	3.5	2.5	2.0	3.5	3.4	4.0	4.0	0.5	3.5	3.5
08C Imnaha River 2	3.2	3.2	2.5	2.0	2.9	2.9	4.0	4.0	0.5	3.5	3.5
08D Imnaha River 3 (Town)	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
08E Horse Creek Confluence	3.5	3.5	2.5	2.0	2.0	2.0	4.0	4.0	2.0	3.5	3.5
08F Pumpkin Creek	3.5	3.5	3.5	2.0	3.5	3.5	4.0	4.0	2.0	3.5	3.5
08G Horse Creek Upper	3.5	3.5	3.5	2.0	3.5	3.5	4.0	4.0	3.5	3.5	3.5
08H Lightning Creek Confluence	3.5	3.5	2.5	3.5	2.0	3.5	4.0	4.0	3.5	3.5	3.5
08I Sleepy Creek	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	3.5	3.5
08J Lightning Creek Upper	3.5	3.5	3.5	2.0	3.5	3.5	4.0	4.0	3.5	3.5	3.5
08K Cow Creek Confluence	3.5	3.5	3.0	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
08L Cow Creek Upper	3.5	2.0	3.5	3.5	3.5	3.5	4.0	4.0	3.5	3.5	3.5
09A Imnaha River 4	2.0	2.0	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
09B Freezeout Creek	3.5	3.5	3.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09C Imnaha River 5	3.5	3.5	2.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09D Grouse Creek Confluence	2.0	3.5	3.5	3.5	2.0	2.7	4.0	4.0	2.0	3.5	3.0
09E Rich Creek/Shadow Canyon	2.0	3.5	3.5	3.0	2.0	3.0	4.0	4.0	2.0	3.5	3.5
09F Grouse Creek Upper	2.0	2.0	3.5	2.0	2.0	2.4	4.0	4.0	3.5	3.5	3.5
09G Imnaha River 6	3.5	3.5	2.5	2.0	2.0	3.5	4.0	4.0	2.0	3.5	3.5

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09H Summit Creek	2.0	2.0	2.0	2.0	2.0	2.0	4.0	4.0	2.0	3.5	3.5
09I Crazyman Creek	3.5	3.5	3.5	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09J Imnaha River 7	3.5	3.5	3.0	3.5	2.0	3.5	4.0	4.0	2.0	3.5	3.5
09K Gumboot Creek	2.0	3.5	3.5	2.0	2.0	2.0	4.0	4.0	2.0	3.5	3.5
09L Imnaha River 8	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09M Imnaha River 9	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09N Imnaha River	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09O North Fork Imnaha River	3.5	3.0	3.5	3.0	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09P South Fork Imnaha River	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	2.0

Reference Conditions – Summer steelhead

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek Mouth	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07B Lower Camp Creek	4.0	4.0	3.8	4.0	3.0	3.8	4.0	4.0	4.0	4.0	3.6
07C Upper Camp Creek	3.5	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
07D Little Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07E Summit Creek (Bear&DowneyGulch)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07F Devils Gulch	4.0	4.0	4.0	4.0	3.5	3.5	4.0	4.0	4.0	4.0	4.0
07G Lightning Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07H Little Sheep Creek 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07I McCully Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07K Big Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07L Squaw Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07M Big Sheep Creek 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07N Marr Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07O Carrol Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07P Big Sheep Creek 3	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07Q Lick Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07R Big/Little Sheep Headwaters	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08A Imnaha River Confluence	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08B Imnaha River 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08C Imnaha River 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08D Imnaha River 3 (Town)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08E Horse Creek Confluence	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08F Pumpkin Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08G Horse Creek Upper	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08H Lightning Creek Confluence	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
08I Sleepy Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08J Lightning Creek Upper	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08K Cow Creek Confluence	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
08L Cow Creek Upper	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09A Imnaha River 4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09B Freezeout Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09C Imnaha River 5	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09D Grouse Creek Confluence	4.0	4.0	4.0	4.0	4.0	3.7	4.0	4.0	4.0	4.0	4.0
09E Rich Creek/Shadow Canyon	4.0	4.0	4.0	4.0	4.0	3.5	4.0	4.0	4.0	4.0	4.0
09F Grouse Creek Upper	4.0	4.0	4.0	4.0	4.0	3.2	4.0	4.0	4.0	4.0	4.0
09G Imnaha River 6	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09H Summit Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09I Crazyman Creek	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09J Imnaha River 7	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09K Gumboot Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09L Imnaha River 8	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09M Imnaha River 9	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09N Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09O North Fork Imnaha River	4.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09P South Fork Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Species Habitat Hypothesis – Summer Steelhead

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Life Stage Rank (1-4)	**4.0**	**3.0**	**3.0**	**2.0**

Assign a weight to each attribute (0-2) relative to its importance to the life stage

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Riparian Condition	0.5	1.0	1.0	0.5
Channel stability	2.0	1.0	1.0	0.5
Habitat Diversity	1.0	2.0	2.0	0.5
Fine sediment	2.0	2.0	2.0	0.5
High Flow	2.0	1.5	1.5	1.5
Low Flow	2.0	2.0	2.0	2.0
Oxygen	2.0	2.0	2.0	2.0

Low Temp	1.0	0.0	0.0	0.0
High Temp	0.5	0.5	0.5	0.5
Pollutants	2.0	2.0	2.0	2.0
Obstructions	0.0	1.0	1.0	2.0

Species Range – Summer Steelhead

	Current Range (0-4)				Reference Range (0-4)			
Reach Name	Spawn and incubation	Summer rearing	Winter rearing	Migration	Spawn and incubation	Summer rearing	Winter rearing	Migration
07A Big Sheep Creek Mouth	0	2	2	2	0	2	2	2
07B Lower Camp Creek	1.5	0.5	0.5	2	1.5	2	2	2
07C Upper Camp Creek	1.4	0.6	0.6	2	1	1	1	2
07D Little Sheep Creek 1	2	2	2	2	2	2	2	2
07E Summit Creek (Bear&DowneyGulch)	2	2	2	2	2	2	2	2
07F Devils Gulch	2	2	2	2	2	2	2	2
07G Lightning Creek	2	2	2	2	2	2	2	2
07H Little Sheep Creek 2	2	2	2	2	2	2	2	2
07I McCully Creek	1	1	1	1	1.5	1.5	1.5	1.5
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	1	1	1	1	1.5	1.5	1.5	1.5
07K Big Sheep Creek 1	2	2	2	2	2	2	2	2
07L Squaw Creek	2	2	2	2	2	2	2	2
07M Big Sheep Creek 2	2	2	2	2	2	2	2	2
07N Marr Creek	2	2	2	2	2	2	2	2
07O Carrol Creek	2	2	2	2	2	2	2	2
07P Big Sheep Creek 3	2	2	2	2	2	2	2	2
07Q Lick Creek	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
07R Big/Little Sheep Headwaters	1	1	1	1	1.625	1.625	1.625	1.625
08A Imnaha River Confluence	0	2	2	2	0	2	2	2
08B Imnaha River 1	0.7	1.3	1.3	2	1.8	2	2	2
08C Imnaha River 2	0.25	1.75	1.75	2	1	2	2	2

Reach Name	Current Range (0-4) Spawn and incubation	Summer rearing	Winter rearing	Migration	Reference Range (0-4) Spawn and incubation	Summer rearing	Winter rearing	Migration
08D Imnaha River 3 (Town)	0.5	1.5	1.5	2	1	2	2	2
08E Horse Creek Confluence	2	2	2	2	2	2	2	2
08F Pumpkin Creek	2	2	2	2	2	2	2	2
08G Horse Creek Upper	2	2	2	2	2	2	2	2
08H Lightning Creek Confluence	2	2	2	2	2	2	2	2
08I Sleepy Creek	1	1	1	1	1	1	1	1
08J Lightning Creek Upper	2	2	2	2	2	2	2	2
08K Cow Creek Confluence	2	2	2	2	2	2	2	2
08L Cow Creek Upper	2	2	2	2	2	2	2	2
09A Imnaha River 4	2	2	2	2	2	2	2	2
09B Freezeout Creek	2	2	2	2	2	2	2	2
09C Imnaha River 5	2	2	2	2	2	2	2	2
09D Grouse Creek Confluence	2	2	2	2	2	2	2	2
09E Rich Creek/Shadow Canyon	2	2	2	2	2	2	2	2
09F Grouse Creek Upper	2	2	2	2	2	2	2	2
09G Imnaha River 6	2	2	2	2	2	2	2	2
09H Summit Creek	2	2	2	2	2	2	2	2
09I Crazyman Creek	2	2	2	2	2	2	2	2
09J Imnaha River 7	2	2	2	2	2	2	2	2
09K Gumboot Creek	2	2	2	2	2	2	2	2
09L Imnaha River 8	2	2	2	2	2	2	2	2
09M Imnaha River 9	2	2	2	2	2	2	2	2
09N Imnaha River	2	2	2	2	2	2	2	2
09O North Fork Imnaha River	1	0	0	0.75	1	0	0	0.75
09P South Fork Imnaha River	0.75	0	0	0.75	1	0	0	0.75

Habitat Scores – Summer Steelhead

	Protection Scores												Restoration Scores											
Reach Name	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek Mouth	-0.3	-0.3	-0.2	-0.2	-0.1	-0.1	-0.3	0.0	0.0	-0.1	-0.6	-0.5	0.3	0.3	0.2	0.3	0.3	0.1	0.3	0.0	0.0	0.6	0.1	0.1
07B Lower Camp Creek	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	0.0	-0.3	-0.5	-0.2	0.2	0.3	0.3	0.2	0.3	0.1	0.3	0.0	0.0	0.3	0.0	0.1
07C Upper Camp Creek	-0.3	-0.2	-0.3	-0.2	-0.2	-0.2	-0.3	0.0	0.0	-0.2	-0.6	-0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.0	0.0	0.3	0.0	0.1
07D Little Sheep Creek 1	-0.4	-0.4	-0.4	-0.3	-0.4	-0.3	-0.4	0.0	0.0	-0.1	-0.9	-0.5	0.4	0.4	0.4	0.5	0.4	0.3	0.4	0.0	0.0	0.8	0.1	0.1
07E Summit Creek (Bear&DowneyGulch)	-0.5	-0.4	-0.6	-0.5	-0.4	-0.5	-0.7	0.0	0.0	-0.5	-0.9	-0.4	0.2	0.4	0.2	0.3	0.4	0.1	0.1	0.0	0.0	0.5	0.1	0.1
07F Devils Gulch	-0.6	-0.5	-0.6	-0.6	-0.5	-0.3	-0.7	0.0	0.0	-0.7	-0.8	-0.5	0.2	0.2	0.2	0.2	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.1
07G Lightning Creek	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3	-0.5	0.0	0.0	-0.5	-0.6	-0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.0	0.0	0.5	0.4	0.3
07H Little Sheep Creek 2	-0.4	-0.4	-0.4	-0.3	-0.4	-0.3	-0.4	0.0	0.0	-0.1	-0.9	-0.3	0.4	0.4	0.4	0.5	0.4	0.3	0.4	0.0	0.0	0.8	0.1	0.3
07I McCully Creek	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	0.0	0.0	-0.4	-0.4	-0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.0	0.0	0.1	0.1	0.2
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	-0.2	-0.2	-0.2	-0.3	0.0	-0.2	-0.2	0.0	0.0	-0.4	-0.4	0.0	0.2	0.3	0.3	0.1	0.5	0.2	0.3	0.0	0.0	0.1	0.1	0.4
07K Big Sheep Creek 1	-0.4	-0.4	-0.4	-0.4	-0.7	-0.3	-0.4	0.0	0.0	-0.1	-0.9	-0.5	0.3	0.4	0.4	0.4	0.1	0.3	0.4	0.0	0.0	0.8	0.1	0.1

	Protection Scores												Restoration Scores											
Reach Name	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07L Squaw Creek	-0.6	-0.5	-0.7	-0.7	-0.7	-0.3	-0.4	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.2	0.1	0.1	0.1	0.3	0.4	0.0	0.0	0.5	0.1	0.1
07M Big Sheep Creek 2	-0.5	-0.4	-0.7	-0.5	-0.7	-0.3	-0.4	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.4	0.1	0.3	0.1	0.3	0.4	0.0	0.0	0.5	0.1	0.1
07N Marr Creek	-0.6	-0.5	-0.7	-0.7	-0.7	-0.3	-0.4	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.2	0.1	0.1	0.1	0.3	0.4	0.0	0.0	0.5	0.1	0.1
07O Carrol Creek	-0.4	-0.4	-0.4	-0.7	-0.1	-0.3	-0.4	0.0	0.0	-0.5	-0.9	-0.3	0.3	0.4	0.4	0.1	0.7	0.3	0.4	0.0	0.0	0.5	0.1	0.3
07P Big Sheep Creek 3	-0.5	-0.4	-0.7	-0.7	-0.4	-0.3	-0.4	0.0	0.0	-0.5	-0.9	-0.3	0.3	0.4	0.1	0.1	0.4	0.3	0.4	0.0	0.0	0.5	0.1	0.3
07Q Lick Creek	-0.5	-0.3	-0.3	-0.6	-0.6	-0.3	-0.4	0.0	0.0	-0.7	-0.8	-0.2	0.2	0.3	0.3	0.1	0.1	0.3	0.4	0.0	0.0	0.1	0.1	0.2
07R Big/Little Sheep Headwaters	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	0.0	0.0	-0.4	-0.4	-0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.3	0.0	0.0	0.1	0.1	0.1
08A Imnaha River Confluence	-0.4	-0.5	-0.4	-0.3	-0.4	-0.3	-0.5	0.0	0.0	-0.1	-0.6	-0.5	0.1	0.1	0.1	0.2	0.1	0.0	0.2	0.0	0.0	0.6	0.1	0.1
08B Imnaha River 1	-0.3	-0.3	-0.4	-0.3	-0.2	-0.3	-0.5	0.0	0.0	-0.1	-0.5	-0.4	0.2	0.2	0.1	0.3	0.4	0.1	0.1	0.0	0.0	0.8	0.1	0.1
08C Imnaha River 2	-0.3	-0.4	-0.4	-0.3	-0.2	-0.2	-0.5	0.0	0.0	-0.1	-0.6	-0.4	0.2	0.1	0.1	0.3	0.3	0.1	0.2	0.0	0.0	0.7	0.1	0.1
08D Imnaha River 3 (Town)	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	0.0	0.0	-0.1	-0.5	-0.4	0.3	0.3	0.3	0.4	0.3	0.2	0.4	0.0	0.0	0.7	0.1	0.1
08E Horse Creek Confluence	-0.5	-0.6	-0.7	-0.5	-0.4	-0.3	-0.4	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.1	0.1	0.3	0.4	0.3	0.4	0.0	0.0	0.5	0.1	0.1
08F Pumpkin Creek	-0.6	-0.6	-0.7	-0.7	-0.4	-0.5	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.1	0.1	0.1	0.4	0.1	0.1	0.0	0.0	0.5	0.1	0.1
08G Horse Creek Upper	-0.6	-0.6	-0.7	-0.7	-0.4	-0.5	-0.7	0.0	0.0	-0.8	-0.9	-0.5	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.0	0.0	0.1	0.1	0.1

	Protection Scores												Restoration Scores											
Reach Name	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
08H Lightning Creek Confluence	-0.6	-0.6	-0.7	-0.5	-0.7	-0.3	-0.7	0.0	0.0	-0.8	-0.9	-0.5	0.1	0.1	0.1	0.3	0.1	0.2	0.1	0.0	0.0	0.1	0.1	0.1
08I Sleepy Creek	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.4	0.0	0.0	-0.4	-0.4	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0
08J Lightning Creek Upper	-0.6	-0.6	-0.7	-0.7	-0.4	-0.5	-0.7	0.0	0.0	-0.8	-0.9	-0.5	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.0	0.0	0.1	0.1	0.1
08K Cow Creek Confluence	-0.6	-0.6	-0.7	-0.6	-0.7	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.0	0.0	0.5	0.1	0.1
08L Cow Creek Upper	-0.6	-0.6	-0.4	-0.7	-0.7	-0.5	-0.7	0.0	0.0	-0.8	-0.9	-0.5	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1
09A Imnaha River 4	-0.4	-0.4	-0.4	-0.3	-0.4	-0.3	-0.4	0.0	0.0	-0.1	-0.9	-0.5	0.4	0.4	0.4	0.5	0.4	0.3	0.4	0.0	0.0	0.8	0.1	0.1
09B Freezeout Creek	-0.6	-0.6	-0.7	-0.7	-0.7	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.5	0.1	0.1
09C Imnaha River 5	-0.6	-0.6	-0.7	-0.5	-0.7	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.1	0.1	0.3	0.1	0.2	0.1	0.0	0.0	0.5	0.1	0.1
09D Grouse Creek Confluence	-0.6	-0.4	-0.7	-0.7	-0.7	-0.3	-0.6	0.0	0.0	-0.5	-0.9	-0.4	0.2	0.4	0.1	0.1	0.1	0.3	0.2	0.0	0.0	0.5	0.1	0.1
09E Rich Creek/Shadow Canyon	-0.6	-0.4	-0.7	-0.7	-0.6	-0.3	-0.6	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.4	0.1	0.1	0.2	0.3	0.1	0.0	0.0	0.5	0.1	0.1
09F Grouse Creek Upper	-0.5	-0.4	-0.4	-0.7	-0.4	-0.3	-0.5	0.0	0.0	-0.8	-0.9	-0.5	0.2	0.4	0.4	0.1	0.4	0.3	0.2	0.0	0.0	0.1	0.1	0.1
09G Imnaha River 6	-0.6	-0.6	-0.7	-0.5	-0.4	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5	0.2	0.1	0.1	0.3	0.4	0.2	0.1	0.0	0.0	0.5	0.1	0.1

	Protection Scores											
Reach Name	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09H Summit Creek	-0.5	-0.4	-0.4	-0.4	-0.4	-0.3	-0.4	0.0	0.0	-0.5	-0.9	-0.5
09I Crazyman Creek	-0.6	-0.6	-0.7	-0.7	-0.7	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5
09J Imnaha River 7	-0.6	-0.6	-0.7	-0.6	-0.7	-0.3	-0.7	0.0	0.0	-0.5	-0.9	-0.5
09K Gumboot Creek	-0.5	-0.4	-0.7	-0.7	-0.4	-0.3	-0.4	0.0	0.0	-0.5	-0.9	-0.5
09L Imnaha River 8	-0.7	-0.6	-0.7	-0.7	-0.7	-0.5	-0.7	0.0	0.0	-0.8	-1.0	-0.5
09M Imnaha River 9	-0.7	-0.6	-0.7	-0.7	-0.7	-0.5	-0.7	0.0	0.0	-0.8	-1.0	-0.5
09N Imnaha River	-0.7	-0.6	-0.7	-0.7	-0.7	-0.5	-0.7	0.0	0.0	-0.8	-1.0	-0.5
09O North Fork Imnaha River	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	0.0	0.0	-0.2	-0.2	-0.1
09P South Fork Imnaha River	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	-0.1	-0.2	0.0

	Restoration Scores											
Reach Name	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09H Summit Creek	0.3	0.4	0.4	0.4	0.4	0.2	0.4	0.0	0.0	0.5	0.1	0.1
09I Crazyman Creek	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.5	0.1	0.1
09J Imnaha River 7	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.0	0.0	0.5	0.1	0.1
09K Gumboot Creek	0.3	0.4	0.1	0.1	0.4	0.3	0.4	0.0	0.0	0.5	0.1	0.1
09L Imnaha River 8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.1
09M Imnaha River 9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.1
09N Imnaha River	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.1
09O North Fork Imnaha River	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09P South Fork Imnaha River	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Habitat Ranks – Summer Steelhead

	Protection Ranks												Restoration Ranks											
Reach Name	Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Rank	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek Mouth	40	4	5	6	8	7	3	10	10	9	1	2	10	5	6	2	4	7	3	10	10	1	8	9
07B Lower Camp Creek	41	7	4	5	6	9	3	10	10	2	1	8	19	5	2	6	3	7	4	9	9	1	9	8
07C Upper Camp Creek	43	9	3	7	6	8	2	10	10	4	1	5	32	6	4	2	3	8	5	9	9	1	9	7
07D Little Sheep Creek 1	31	6	4	8	5	7	3	10	10	9	1	2	2	6	4	2	5	7	3	10	10	1	8	9
07E Summit Creek (Bear&DowneyGulch)	20	9	3	5	8	4	2	10	10	6	1	7	16	3	5	4	2	9	8	10	10	1	6	7
07F Devils Gulch	14	6	4	4	8	9	2	10	10	3	1	7	26	7	5	5	1	3	9	9	9	4	2	8
07G Lightning Creek	30	7	4	4	6	8	2	10	10	3	1	9	4	6	2	2	4	7	7	10	10	1	4	9
07H Little Sheep Creek 2	34	5	3	7	4	6	2	10	10	9	1	8	1	6	4	2	5	7	3	10	10	1	9	8
07I McCully Creek	38	6	3	3	5	8	7	10	10	2	1	9	36	9	6	6	8	2	1	10	10	5	4	3
07J Little Sheep Creek 3 (Redmont, Ferg., Canal)	44	6	5	3	8	7	4	10	10	2	1	9	14	5	4	9	1	6	3	10	10	8	7	2
07K Big Sheep Creek 1	28	7	5	5	2	8	4	10	10	9	1	3	6	5	3	3	8	6	2	10	10	1	7	9
07L Squaw Creek	15	5	2	2	4	9	8	10	10	7	1	6	22	4	6	6	8	3	2	10	10	1	5	9
07M Big Sheep Creek 2	22	8	2	4	3	9	7	10	10	6	1	5	13	3	7	5	8	4	2	10	10	1	6	9
07N Marr Creek	15	5	2	2	4	9	8	10	10	7	1	6	22	4	6	6	8	3	2	10	10	1	5	9

	Protection Ranks												Restoration Ranks											
Reach Name	**Reach Rank**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	**Reach Rank**	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07O Carrol Creek	**29**	6	5	2	9	7	4	10	10	3	1	8	**5**	5	4	9	1	6	3	10	10	2	8	7
07P Big Sheep Creek 3	**25**	7	2	2	6	8	5	10	10	4	1	9	**9**	4	8	8	3	5	2	10	10	1	7	6
07Q Lick Creek	**26**	7	6	3	4	8	5	10	10	2	1	9	**20**	3	2	8	9	4	1	10	10	7	6	5
07R Big/Little Sheep Headwaters	**39**	5	4	3	8	9	7	10	10	2	1	6	**29**	6	4	8	2	3	1	10	10	7	5	9
08A Imnaha River Confluence	**33**	3	5	7	6	8	2	10	10	9	1	3	**33**	5	7	2	8	9	3	10	10	1	4	5
08B Imnaha River 1	**37**	5	3	6	8	7	2	10	10	9	1	4	**15**	4	7	3	2	8	5	10	10	1	6	9
08C Imnaha River 2	**36**	4	5	6	8	7	2	10	10	9	1	3	**18**	6	6	3	2	5	4	10	10	1	8	9
08D Imnaha River 3 (Town)	**42**	4	5	7	6	8	3	10	10	9	1	2	**7**	4	4	2	6	7	3	10	10	1	8	9
08E Horse Creek Confluence	**23**	3	2	4	8	9	7	10	10	6	1	5	**12**	8	7	5	3	4	2	10	10	1	6	9
08F Pumpkin Creek	**10**	5	3	3	9	6	2	10	10	8	1	7	**27**	7	5	5	2	8	4	10	10	1	3	9
08G Horse Creek Upper	**4**	6	4	4	9	7	3	10	10	2	1	8	**38**	7	5	5	1	8	4	10	10	3	2	9
08H Lightning Creek Confluence	**7**	6	4	7	5	9	3	10	10	2	1	8	**40**	8	6	1	7	2	5	10	10	4	3	9
08I Sleepy Creek	**35**	7	4	4	6	8	3	10	10	2	1	9	**44**	7	4	4	6	8	3	10	10	2	1	9
08J Lightning Creek Upper	**4**	6	4	4	9	7	3	10	10	2	1	8	**38**	7	5	5	1	8	4	10	10	3	2	9
08K Cow Creek Confluence	**11**	5	3	6	4	9	2	10	10	8	1	7	**30**	8	6	2	7	3	5	10	10	1	4	9
08L Cow Creek Upper	**6**	6	9	4	5	7	3	10	10	2	1	8	**37**	7	1	5	6	8	4	10	10	3	2	9

Reach Name	Protection Ranks: Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Restoration Ranks: Reach Rank	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09A Imnaha River 4	31	6	4	8	5	7	3	10	10	9	1	2	2	6	4	2	5	7	3	10	10	1	8	9
09B Freezeout Creek	8	6	3	3	5	9	2	10	10	8	1	7	34	8	5	5	7	2	4	10	10	1	3	9
09C Imnaha River 5	13	5	3	6	4	9	2	10	10	8	1	7	28	8	6	2	7	3	5	10	10	1	4	9
09D Grouse Creek Confluence	19	8	2	2	4	9	5	10	10	6	1	7	21	2	7	7	9	3	4	10	10	1	6	5
09E Rich Creek/Shadow Canyon	17	8	2	2	5	9	4	10	10	7	1	6	24	2	7	7	4	3	6	10	10	1	5	9
09F Grouse Creek Upper	21	8	6	3	7	9	4	10	10	2	1	5	17	3	1	8	2	4	5	10	10	7	6	9
09G Imnaha River 6	18	4	3	5	8	9	2	10	10	7	1	6	25	8	7	3	2	4	6	10	10	1	5	9
09H Summit Creek	27	8	5	5	7	9	4	10	10	3	1	2	8	6	3	3	5	7	2	10	10	1	8	9
09I Crazyman Creek	8	6	3	3	5	9	2	10	10	8	1	7	34	8	5	5	7	2	4	10	10	1	3	9
09J Imnaha River 7	11	5	3	6	4	9	2	10	10	8	1	7	30	8	6	2	7	3	5	10	10	1	4	9
09K Gumboot Creek	24	8	2	2	7	9	6	10	10	5	1	4	11	4	7	7	3	5	2	10	10	1	6	9
09L Imnaha River 8	1	7	4	4	6	8	3	10	10	2	1	9	41	6	3	3	5	7	2	9	9	1	9	8
09M Imnaha River 9	1	7	4	4	6	8	3	10	10	2	1	9	41	6	3	3	5	7	2	9	9	1	9	8
09N Imnaha River	1	7	4	4	6	8	3	10	10	2	1	9	41	6	3	3	5	7	2	9	9	1	9	8
09O North Fork Imnaha River	45	8	4	7	5	3	6	10	10	2	1	9	46	5	7	4	7	2	3	7	7	1	7	6
09P South Fork Imnaha River	46	8	2	7	4	4	6	10	10	2	1	9	45	8	2	7	4	4	6	9	9	3	9	1

Existing Conditions – Bull Trout

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	2.0	2.0	1.5	0.5	2.0	2.0	4.0	4.0	0.5	2.0	3.5
07D Little Sheep Creek 1	0.5	3.5	1.5	1.5	2.0	2.0	4.0	4.0	0.5	2.0	3.5
07H Little Sheep Creek	3.5	3.5	1.5	1.5	2.0	1.5	4.0	4.0	0.5	1.0	2.0
07I McCully Creek	2.5	3.5	3.5	2.0	3.5	3.3	4.0	4.0	3.5	2.0	0.5
07J Little Sheep Creek Headwaters	3.4	3.5	3.5	2.0	3.0	2.0	4.0	4.0	2.0	3.5	0.5
07K Big Sheep Creek 1	1.5	2.0	2.0	2.0	2.0	2.0	4.0	4.0	0.5	2.0	3.5
07M Big Sheep Creek 2	1.5	3.5	2.5	2.0	3.5	3.5	4.0	4.0	2.0	2.0	3.5
07P Big Sheep Creek 3	1.5	2.0	3.5	2.8	2.8	2.8	4.0	4.0	0.5	3.5	2.0
07Q Lick Creek	1.0	3.5	3.5	3.5	2.0	3.0	4.0	4.0	3.5	3.5	2.0
07R Big Sheep Creek 4 (headwaters)	2.0	3.0	3.0	2.5	2.5	2.6	4.0	4.0	3.0	3.5	0.5
08A Imnaha River Confluence	3.5	3.5	2.5	2.0	2.0	3.5	4.0	4.0	0.5	3.5	3.5
08B Imnaha River 1	2.0	2.0	2.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
08C Imnaha River 2	2.0	3.5	2.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
08D Imnaha River 3	2.0	3.5	1.5	2.0	2.0	2.0	4.0	4.0	0.5	3.5	3.5
09A Imnaha River 4	3.5	3.5	1.5	2.0	3.5	3.5	4.0	4.0	0.5	3.5	3.5
09C Imnaha River 5	3.5	3.5	2.5	2.0	3.5	3.5	4.0	4.0	0.5	3.5	3.5
09G Imnaha River 6	3.5	3.5	2.5	2.0	3.5	3.5	4.0	4.0	0.5	3.5	3.5
09J Imnaha River 7	3.5	3.5	3.0	2.0	3.5	3.5	4.0	4.0	2.5	3.5	2.0
09L Imnaha River 8	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	2.5	4.0	3.5
09M Imnaha River 9	3.5	3.5	3.5	3.5	3.5	3.5	4.0	4.0	3.5	4.0	3.5
09N Imnaha River	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09O North Fork Imnaha River	4.0	3.0	4.0	2.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09P South Fork Imnaha River	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Reference Conditions – Bull Trout

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07D Little Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07H Little Sheep Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07I McCully Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07J Little Sheep Creek Headwaters	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07K Big Sheep Creek 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07M Big Sheep Creek 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07P Big Sheep Creek 3	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
07Q Lick Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
07R Big Sheep Creek 4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08A Imnaha River Confluence	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08B Imnaha River 1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08C Imnaha River 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
08D Imnaha River 3	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09A Imnaha River 4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
09C Imnaha River 5	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0	4.0
09G Imnaha River 6	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0	4.0
09J Imnaha River 7	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
09L Imnaha River 8	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09M Imnaha River 9	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09N Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09O North Fork Imnaha River	4.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
09P South Fork Imnaha River	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Species Habitat Hypothesis – Bull Trout

	Spawning/incubation	Summer Rearing	Winter Rearing	Migration
Life Stage Rank (1-4)	3.0	3.0	3.0	2.0
Assign a weight to each attribute (0-2) relative to its importance to the life stage				
Riparian Condition	1.0	2.0	2.0	0.5
Channel stability	2.0	2.0	2.0	0.5
Habitat Diversity	1.0	2.0	2.0	0.5
Fine sediment	2.0	2.0	2.0	0.5
High Flow	2.0	1.0	1.0	0.5
Low Flow	2.0	2.0	2.0	2.0
Oxygen	2.0	2.0	2.0	2.0
Low Temp	0.5	0.0	0.0	0.0
High Temp	2.0	2.0	2.0	2.0
Pollutants	2.0	2.0	2.0	2.0
Obstructions	1.0	1.0	1.0	2.0

Species Range – Bull Trout

Reach Name	Current Range (0-4)				Reference Range (0-4)			
	Spawn and incubation	Summer rearing	Winter rearing	Migration	Spawn and incubation	Summer rearing	Winter rearing	Migration
07A Big Sheep Creek	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07D Little Sheep Creek 1	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07H Little Sheep Creek	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07I McCully Creek	1.3	0.8	0.8	2.0	2.0	1.5	1.5	2.0
07J Little Sheep Creek Headwaters	0.8	0.8	0.3	2.0	1.0	1.0	1.0	2.0
07K Big Sheep Creek 1	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07M Big Sheep Creek 2	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
07P Big Sheep Creek 3	1.0	0.5	0.5	2.0	1.0	1.0	1.0	2.0
07Q Lick Creek	2.0	1.0	1.0	0.0	2.0	1.0	1.0	0.0
07R Big Sheep Creek 4 (headwaters)	2.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0
08A Imnaha River Confluence	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
08B Imnaha River 1	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
08C Imnaha River 2	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
08D Imnaha River 3	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
09A Imnaha River 4	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
09C Imnaha River 5	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0
09G Imnaha River 6	1.5	0.0	0.0	2.0	2.0	0.0	0.0	2.0
09J Imnaha River 7	2.0	0.5	1.0	2.0	2.0	1.0	1.0	2.0
09L Imnaha River 8	2.0	0.5	1.0	2.0	2.0	1.0	1.0	2.0
09M Imnaha River 9	2.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0
09N Imnaha River	2.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0
09O North Fork Imnaha River	2.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0
09P South Fork Imnaha River	2.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0

Habitat Scores – Bull Trout

	Protection Scores												Restoration Scores											
Reach Name	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.2	**0.1**	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0
07D Little Sheep Creek 1	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0
07H Little Sheep Creek	**0.0**	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1	**0.1**	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1
07I McCully Creek	**-0.3**	-0.2	-0.4	-0.3	-0.2	-0.3	-0.5	0.0	0.0	-0.5	-0.3	0.0	**0.2**	0.2	0.1	0.1	0.4	0.1	0.1	0.0	0.0	0.1	0.4	0.5
07J Little Sheep Creek Headwaters	**-0.2**	-0.2	-0.2	-0.2	-0.1	-0.2	-0.2	0.0	0.0	-0.2	-0.4	0.0	**0.2**	0.1	0.1	0.0	0.2	0.1	0.3	0.0	0.0	0.3	0.1	0.3
07K Big Sheep Creek 1	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0
07M Big Sheep Creek 2	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	-0.1	-0.1	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
07P Big Sheep Creek 3	**-0.2**	-0.1	-0.2	-0.2	-0.2	-0.2	-0.3	0.0	0.0	-0.1	-0.4	-0.2	**0.2**	0.2	0.2	0.0	0.1	0.1	0.2	0.0	0.0	0.4	0.1	0.2
07Q Lick Creek	**-0.3**	-0.1	-0.5	-0.4	-0.5	-0.2	-0.4	0.0	0.0	-0.5	-0.5	-0.1	**0.1**	0.3	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.1	0.1	0.1
07R Big Sheep Creek 4 (headwaters)	**-0.5**	-0.3	-0.5	-0.4	-0.5	-0.3	-0.6	0.0	0.0	-0.6	-0.8	-0.1	**0.3**	0.4	0.2	0.2	0.3	0.2	0.3	0.0	0.0	0.3	0.1	0.5
08A Imnaha River Confluence	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	-0.2	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
08B Imnaha River 1	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.2	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0
08C Imnaha River 2	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.2	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0
08D Imnaha River 3	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.2	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0

	Protection Scores												Restoration Scores											
Reach Name	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	**Reach Score**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09A Imnaha River 4	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	-0.2	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
09C Imnaha River 5	**-0.1**	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	-0.2	-0.2	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
09G Imnaha River 6	**-0.2**	-0.1	-0.2	-0.1	-0.1	-0.2	-0.3	0.0	0.0	0.0	-0.3	-0.2	**0.1**	0.0	0.0	0.1	0.2	0.0	0.1	0.0	0.0	0.3	0.1	0.0
09J Imnaha River 7	**-0.4**	-0.3	-0.5	-0.3	-0.3	-0.4	-0.6	0.0	0.0	-0.4	-0.6	-0.2	**0.1**	0.1	0.1	0.1	0.3	- 0.1	0.1	0.0	0.0	0.3	0.1	0.2
09L Imnaha River 8	**-0.4**	-0.3	-0.5	-0.3	-0.5	-0.4	-0.6	0.0	0.0	-0.4	-0.7	-0.4	**0.1**	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.3	0.0	0.1
09M Imnaha River 9	**-0.5**	-0.4	-0.5	-0.4	-0.5	-0.4	-0.6	0.0	0.0	-0.6	-0.7	-0.4	**0.1**	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.1
09N Imnaha River	**-0.6**	-0.5	-0.6	-0.5	-0.4	-0.5	-0.7	0.0	0.0	-0.7	-0.7	-0.5	**0.0**	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09O North Fork Imnaha River	**-0.5**	-0.5	-0.4	-0.5	-0.4	-0.5	-0.7	0.0	0.0	-0.7	-0.7	-0.5	**0.0**	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09P South Fork Imnaha River	**-0.6**	-0.5	-0.6	-0.5	-0.4	-0.5	-0.7	0.0	0.0	-0.7	-0.7	-0.5	**0.0**	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Habitat Ranks – Bull Trout

	Protection Ranks												Restoration Ranks											
Reach Name	**Reach Rank**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	**Reach Rank**	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
07A Big Sheep Creek	**22**	4	4	8	9	4	2	10	10	4	2	1	**11**	6	6	5	4	6	2	10	10	1	2	6
07D Little Sheep Creek 1	**21**	9	4	7	7	5	2	10	10	5	2	1	**12**	4	9	5	5	7	2	10	10	1	2	7
07H Little Sheep Creek	**23**	4	4	8	8	6	2	10	10	6	3	1	**10**	8	8	5	5	7	2	10	10	2	1	4
07 I McCully Creek	**9**	8	3	4	7	5	2	10	10	1	6	9	**2**	4	7	8	3	9	5	10	10	6	2	1
07J Little Sheep Creek Headwaters	**11**	6	2	5	8	7	3	10	10	3	1	9	**4**	8	7	9	4	5	2	10	10	2	6	1
07K Big Sheep Creek 1	**20**	9	4	4	4	4	2	10	10	4	2	1	**13**	4	5	5	5	5	2	10	10	1	2	5
07M Big Sheep	**16**	9	5	7	8	5	1	10	10	3	3	1	**18**	3	8	7	4	8	4	10	10	2	1	4

	Protection Ranks													Restoration Ranks											
Reach Name	**Reach Rank**	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions		**Reach Rank**	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
Creek 2																									
07P Big Sheep Creek 3	**10**	8	6	3	3	5	2	10	10	9	1	6		**3**	2	3	9	6	7	5	10	10	1	8	4
07Q Lick Creek	**8**	9	1	6	1	7	5	10	10	1	1	8		**6**	1	5	9	5	2	3	10	10	5	5	3
07R Big Sheep Creek 4 (headwaters)	**5**	8	4	6	5	7	3	10	10	2	1	9		**1**	2	7	8	4	6	3	10	10	5	9	1
08A Imnaha River Confluence	**15**	4	4	6	7	7	1	10	10	7	1	1		**17**	8	8	7	2	2	2	10	10	1	2	2
08B Imnaha River 1	**19**	5	5	4	5	5	3	10	10	5	1	1		**14**	3	3	9	3	3	2	10	10	1	3	3
08C Imnaha River 2	**17**	6	4	5	6	6	3	10	10	6	1	1		**16**	3	9	8	3	3	2	10	10	1	3	3
08D Imnaha River 3	**18**	5	4	9	5	5	3	10	10	5	1	1		**15**	4	9	3	4	4	2	10	10	1	4	4
09A Imnaha River 4	**14**	4	4	9	7	4	1	10	10	7	1	1		**19**	7	7	2	3	7	3	10	10	1	3	3

Protection Ranks

Reach Name	Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09C Imnaha River 5	13	4	4	7	8	4	1	10	10	8	1	1
09G Imnaha River 6	12	6	4	8	7	4	1	10	10	9	1	3
09J Imnaha River 7	7	6	3	7	8	5	1	10	10	4	1	9
09L Imnaha River 8	6	8	3	8	3	6	2	10	10	5	1	6
09M Imnaha River 9	4	6	4	6	4	6	2	10	10	2	1	6
09N Imnaha River	1	5	4	5	9	5	1	10	10	1	1	5
09O North Fork Imnaha River	3	4	8	4	9	4	1	10	10	1	1	4
09P South Fork Imnaha River	1	5	4	5	9	5	1	10	10	1	1	5

Restoration Ranks

Reach Name	Reach Rank	Riparian Condition	Channel form	Channel complexity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
09C Imnaha River 5	20	7	7	6	2	11	2	9	9	1	2	2
09G Imnaha River 6	8	8	6	3	2	11	4	9	9	1	4	6
09J Imnaha River 7	5	8	7	4	1	11	5	9	9	2	5	3
09L Imnaha River 8	7	5	3	5	3	5	2	9	9	1	9	5
09M Imnaha River 9	9	5	3	5	3	5	1	9	9	1	9	5
09N Imnaha River	21	2	2	2	1	2	2	2	2	2	2	2
09O North Fork Imnaha River	23	2	2	2	1	2	2	2	2	2	2	2
09P South Fork Imnaha River	21	2	2	2	1	2	2	2	2	2	2	2