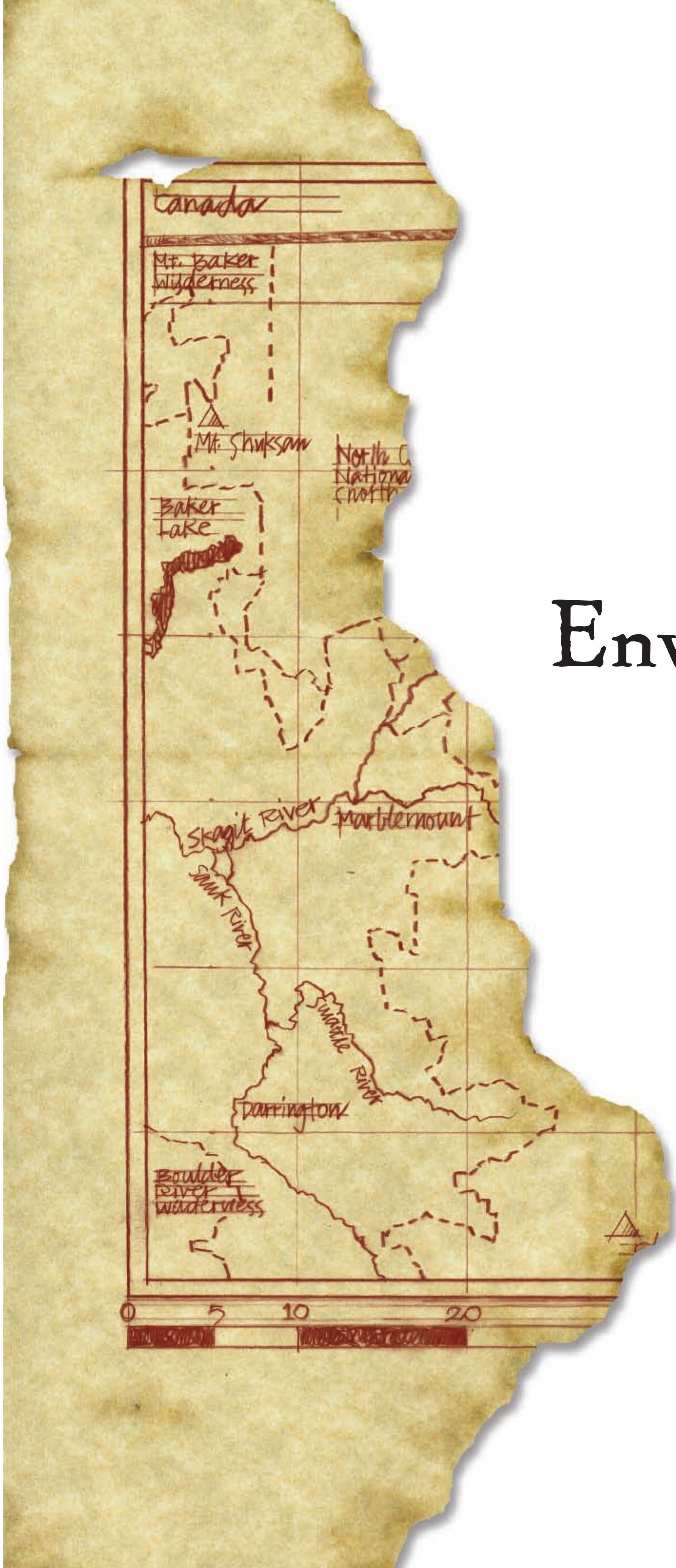


Affected Environment

Welcome

You are now in the "Affected Environment" chapter. Here are the topics you can read about.

INTRODUCTION

THIS "AFFECTED ENVIRONMENT" chapter describes the resources of the North Cascades National Park Service Complex (also referred to in the document as the "North Cascades Complex") that could be affected as a result of implementation of any of the proposed fishery management alternatives. The resource descriptions provided in this chapter serve as the baseline from which to compare the potential effects of the management actions considered in this *Draft Mountain Lakes Fishery Management Plan / Environmental Impact Statement* (plan/EIS). The resource topics presented in this chapter, and the organization of the topics, correspond to the resource impact discussions contained in the "Environmental Consequences" chapter that follows this chapter.

GENERAL PROJECT SETTING

GEOGRAPHIC SETTING

The National Park Service (NPS) administers three units that make up the North Cascades Complex. Those three units are North Cascades National Park (505,000 acres), Ross Lake National Recreation Area (117,000 acres), and Lake Chelan National Recreation Area (62,000 acres). The North Cascades Complex is located in the northernmost portion of the Cascade Mountain Range in northwestern Washington State (refer to "Figure 1: Vicinity Map" in the "Purpose of and Need for Action" chapter). The North Cascades Complex is surrounded by approximately 6 million acres of National Forest System lands, including the Mount Baker-Snoqualmie National Forest to the south and the Okanogan National Forest to the east.

North Cascades National Park is divided into two administrative units: the North Unit and the South Unit. These two units are split geographically by Ross Lake National Recreation Area, which contains three reservoirs (Ross, Diablo, and Gorge lakes) created by the dams of the Skagit River Hydroelectric Project. The lakes provide a variety of recreational opportunities such as boating, sport fishing, tours of the hydroelectric facilities, and short hiking trails. The Skagit River Hydroelectric Project includes two small "company" towns: Newhalem and Diablo. It also includes a very large infrastructure of dams, penstocks, power houses, and associated maintenance facilities. In partnership with NPS and the North Cascades Institute, Seattle City Light is constructing an Environmental Learning Center on the shores of Diablo Lake.

Ross Lake has two developed areas that provide recreational opportunities for park visitors: Ross Lake Resort and Hozomeen. Located in the shadow of Ross

Dam, Ross Lake Resort is a small assemblage of floating cottages operated by a private concessioner. Hozomeen is a semiprimitive visitor-use area situated in Ross Lake National Recreation Area on the United States-Canadian border. Visitor amenities at Hozomeen include several campgrounds, a boat launch, several docks, and a trail leading to Hozomeen Lake and points beyond. The Silver-Skagit Road, which originates near Hope, British Columbia, is the only road access to Hozomeen. Visitors can also access Hozomeen by boat but only when Ross Lake Reservoir is at or near full pool. Predominant visitor use is camping, boating, and sport fishing. Many visitors to Hozomeen are Canadian citizens. Approximately 8,200 people visited Hozomeen in 2002.

The last major developed area in Ross Lake National Recreation Area is the highway corridor along State Route 20, commonly referred to as the "North Cascades Highway," which provides the only road access across the North Cascades Complex. State Route 20 is closed in winter because of heavy snowfall and avalanche dangers. There are a variety of trailheads and rest stops along the highway that provide viewpoints and access to the remote interior portions of the North Cascades Complex. In 1992 the average vehicle use along State Route 20 through Ross Lake National Recreation Area was approximately 1,300 vehicles per day (WDOT 2002).

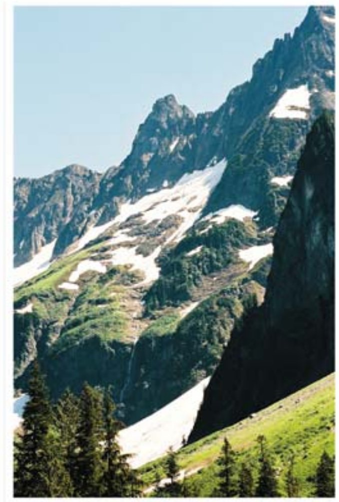
The community of Stehekin is the only development in Lake Chelan National Recreation Area. Situated at the head of Lake Chelan, Stehekin is a settlement of year-round and summer homes and recreation-oriented businesses. There is no road access to Stehekin. The only access is by trail, ferry, boat, or small airplane. The Stehekin Valley Road, a 21 mile dead-end road, leads north from Stehekin into the interior portions of the North Cascades Complex.

The North Cascades Complex has approximately 386 miles of maintained trails, including a portion of the Pacific Crest Trail that runs from southern California to the Canadian border. There is also a network of climbing routes and way-trails throughout the North Cascades Complex that lead to various mountaineering, sport fishing, and other backcountry destinations. The NPS does not formally maintain these trails.

WILDERNESS

Approximately 634,600 acres, or 93%, of the North Cascades Complex are designated and managed as wilderness (NPS 1989) under the provisions of the *Wilderness Act of 1964*. Roughly 1.6 million acres of National Forest System lands that surround the North Cascades Complex are also designated as wilderness. To the east are the Pasayten Wilderness (529,477 acres) and Lake Chelan-Sawtooth Wilderness (151,435 acres); to the south is the Glacier Peak Wilderness (570,573 acres); and to the west are the Mount Baker Wilderness (117,528 acres) and Noisy-Diobsud Wilderness (14,133 acres).

The border between the United States and Canada forms the northern boundary of North Cascades National Park and Ross Lake National Recreation Area. Just over the border into Canada are E.C. Manning Provincial Park, Skagit Valley Provincial Park, Chilliwack Lake Provincial Park, and various forest lands administered by the province of British Columbia. Though not designated as "wilderness," these Canadian protected areas are, for the most part, extremely rugged, wild, and remote, and they further complement the wilderness buffer that largely surrounds the North Cascades Complex. It is particularly important to note that these Canadian areas provide habitat corridors and source populations of medium- and large-sized mammals of conservation significance, such as grizzly bears and wolves.



The North Cascades Complex contains some of the most rugged and remote wilderness in the contiguous United States.

Because the North Cascades Complex is almost 93% wilderness, the majority of lands in the national park and two national recreation areas have not been developed. In accordance with the *General Management Plan* (NPS 1988b) for the North Cascades Complex, these areas are managed as "natural zones" to ensure that natural resources and processes remain largely unaltered by human activity. All of the natural lakes in the North Cascades Complex fall under the "natural zone" category for management purposes.

Research Natural Areas, which are special subzones of natural zones, were given that designation by the NPS because of their unique natural features with essentially no past human influence. There are five Research Natural Areas in the North Cascades Complex. Two of these, Silver Lake Research Natural Area (1,627 acres) and Pyramid Lake Research Natural Area (164 acres), are centered around mountain lakes. Silver Lake was last stocked in 1961, and surveys performed in 1980 showed no fish remained in the lake. Pyramid Lake was last stocked in 1968, and surveys performed as recently as 1999 indicated no fish remained in the lake. Although both lakes were stocked in the past, current management of Research Natural Areas involves strict protection of their scientific values.

GEOLOGIC OVERVIEW

This section provides an overview of the geology of the North Cascades Complex to demonstrate the inextricable link between hydrology and geology. The geology of the North Cascades Complex has a profound influence on various hydrologic processes such as rainfall, runoff, and the physical structure of lakes and streams and their associated water quality.

Metamorphism: In geological terms, the changes in the composition and texture of rocks caused by heat, pressure, moisture, and other factors.

Geologists have divided the region into three main geologic domains. From west to east, these domains include the Western domain, the Metamorphic domain, and the Methow domain.

The Western domain consists mostly of sedimentary and volcanic rocks of marine origin. Notable peaks in this domain include Mount Baker and Mount Shuksan.

The Metamorphic domain is composed of metamorphosed crystalline rocks, such as the steep vertical layers of granite that were formed under intense heat and pressure deep within the earth. Often referred to as the "crystalline core," this domain is most visibly expressed in the rugged, remote peaks of the Picket Range.

Tectonic: The study of the movement and deformation of the earth's crust.

East of the Cascade Crest lies the Methow domain, composed of unmetamorphosed sedimentary rocks of marine and volcanic origin. This domain is separated from the Metamorphic domain by the Ross Lake fault. Each of the three geologic domains consists of many tectonic terrains, or relatively homogenous sections (in other words, the same character or composition throughout) of the earth's crust that have formed according to the geologic principles of plate tectonics. The many different tectonic terrains create an exceedingly complex mountain mosaic of many different types of rock (Tabor and Haugerud 1999).

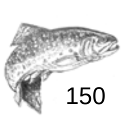
The Metamorphic domain consists of two major mountain divides: the Skagit Crest and the Pacific Crest. These two divides have a profound influence on the climate and hydrology of the North Cascades Complex. The Picket Range and Eldorado Range form the boundary of the Skagit Crest. The Pacific Crest Trail roughly forms the boundary of the Pacific Crest, which lies further east. These two mountain divides give rise to three hydrologic zones: the first is west of the Skagit Crest; the second is the Central basin, which is also referred to as the Ross Lake basin; and the third lies east of the Cascade Crest. Moving from west to east along these hydrologic zones, precipitation and runoff decline substantially due to the rain shadow effect produced by the high peaks of the Skagit Crest. The Cascade Crest creates a climatic barrier between the west-side maritime climate and the east-side semiarid continental climate. This climatic barrier is useful for distinguishing between "west-side" and "east-side" lakes, though this classification is slightly complicated by the rain shadow effect produced in the lee of the Picket Range in the area around Ross Lake. Based on records from nearby weather stations, the average annual precipitation is about 100 inches on the west side and 60 inches on the east side.

The Picket Range (shown above), along with the Eldorado Range, form the boundary of the Skagit Crest.

HYDROLOGY OF THE NORTH CASCADES COMPLEX

The creeks and rivers of the North Cascades Complex drain into three regional watersheds: the Skagit River watershed, the Fraser River watershed (via the Chilliwack River), and the Columbia River watershed (via the Stehekin River). The Skagit River is the largest watershed in the Puget Sound area. Major tributaries that enter the Skagit, or that drain significant parts of the North Cascades Complex, include Little Beaver, Lightning, Big Beaver, Devils, Ruby, and Thunder creeks and the Cascade River. The Stehekin River drains into Lake Chelan and eventually into the Columbia River. The Chilliwack River originates in the northwest corner of the North Cascades Complex and drains northward into the Fraser River. "Map 1" is located in the envelope that accompanied this document and shows the creeks, rivers, lakes, and reservoirs described in this chapter.

Ross Lake National Recreation Area contains three reservoirs along the Skagit River: Ross Lake (11,680 acres), Diablo Lake (910 acres), and Gorge Lake (210 acres). These three reservoirs make up the Skagit River Hydroelectric



Project, owned and managed by Seattle City Light. Although these reservoirs were considered in the impact analysis portion (the "Environmental Consequences" chapter) of this plan/EIS, they are beyond the scope of this document because they are manmade reservoirs and not naturally formed mountain lakes.

Geologists believe that the Skagit River once flowed northward into the Fraser River drainage. At the end of the last ice age (about 13,000 years ago), huge amounts of glacial meltwater were blocked by the Cordilleran ice sheet, and this blockage caused the Skagit River to reverse course and carve out the Skagit River gorge between Newhalem and Diablo. This phenomenon, called drainage reversal, was widespread in the North Cascades Range (Tabor and Haugerud 1999). As a result of drainage reversal, the Skagit River watershed can be broken down into upper and lower reaches. The Upper Skagit watershed extends well into Canada and includes the upper sections of the Skagit River, Ross Lake, and various other smaller creeks including Big Beaver, Little Beaver, Lightning, and Thunder. The Lower Skagit River watershed begins in the Skagit River gorge between the towns of Diablo and Newhalem. Major tributaries to the Lower Skagit watershed in the North Cascades Complex include the Cascade River and the upper reaches of Baker River, upstream of Baker Lake.

Glaciers play a significant role in the hydrology of many of the streams and lakes in the North Cascades Complex.

On the east side of the Cascade Crest is the Stehekin River drainage. Most of the Stehekin River watershed is in the North Cascades Complex and the Glacier Peak Wilderness. Major tributaries along its course include five creeks: Bridge, Company, Agnes, Rainbow, and Boulder. Near the southern end of Lake Chelan National Recreation Area, the Stehekin River joins the deep blue-green waters of Lake Chelan.

Lake Chelan, perhaps one of the most remarkable examples of glacial erosion in the North Cascades Complex, is a natural lake 50 miles long (4 miles of which are in the Lake Chelan National Recreation Area) and 1,500 feet deep—one of the deepest lakes in North America. A dam constructed in 1927 added 21 feet to the level of Lake Chelan, giving it a full-pool surface elevation of approximately 1,010 feet above mean sea level (the 1982 to 1990 mean). The lake levels fluctuate on an annual basis, with an average drawdown of 18 feet by late winter / early spring to accommodate snowmelt for hydropower generation. Full pool is usually restored by early July.

The Stehekin River originates as snow and glacial meltwater near Cascade Pass.

The glaciers provide extremely cold water, help maintain summer base flows in the dry summer season following spring snowmelt, and contribute high loads of suspended sediment and various nutrients to lakes and rivers. The North Cascades Complex has approximately 330 glaciers. The minimum elevations of glaciers (glacier threshold) rise from west to east across the North Cascades Range due to lower snow accumulations and higher summer temperatures on the eastern slope of the range. Along the Pacific Crest portion of the North Cascades Complex, most glaciers are located south of Cascade Pass. North of Cascade Pass, most of the glaciers are found along the crest of the Skagit Range (also referred to as the Eldorado and Picket ranges). Throughout the North Cascades Complex, glaciers are located primarily on cooler north- and east-facing slopes.

The lakes in the North Cascades Complex can be classified according to the geologic processes, particularly the glacial processes, that formed them. This method of classification is commonly referred to as lake morphometry (Wetzel 2001).

Glacier monitoring data indicate that the glaciers are melting rapidly. Since the end of the Little Ice Age in the late 1800s, glaciers have retreated throughout the North Cascades Complex, and it is likely that over 100 glaciers have disappeared from the North Cascades Complex since the late 19th century. Continuing shrinkage and disappearance of glaciers in the North Cascades Complex mean that its hydrology, aquatic ecosystems, and vegetation are changing as well. One result of glacial melting is that new lakes are being formed, and existing cirque lakes are expanding as their parent glaciers melt. Silver Lake is an excellent example of such a lake. From 1901 to 1906, Canadian geologist Reginald Daly mapped the glacier on Mt. Spickard (then Glacier Peak) as entirely covering the lake basin. Today, the glacier has retreated significantly and exposed an indigo-colored lake (Silver Lake) over 1 mile long (Beckey 1995) and more than 500 feet deep.

Aside from glacial runoff, flooding plays an important role in the hydrology of the North Cascades Complex, and floods can happen at any time of year, but are more common under certain conditions. Summer floods usually occur during thunderstorms and associated periods of intense rainfall. These floods usually affect areas that are less than 10 square miles in size. Spring floods occur in May or June during peak snowmelt. The magnitude of these floods varies depending on the depth of winter snowpack and spring weather (precipitation, freezing level, and temperature). The most extreme flood events usually occur in winter during heavy rain events associated with unusually warm temperatures (high freezing level) and a pre-existing heavy snowpack.

OVERVIEW OF MOUNTAIN LAKES

The North Cascades Complex has 561 permanent natural water bodies that include lakes, tarns (small mountain lakes formed by glaciers), and ponds. There are an unknown number of seasonal ponds that flood following snow melt but eventually dry up over the course of the summer. Approximately 245 of the permanent water bodies are considered mountain lakes because of their larger size and depth. Also, lakes and ponds are usually distinguished according to whether or not sunlight can reach the bottom (Wetzel 2001). For the purpose of this plan/EIS, each of the 91 water bodies with a history of fish stocking is considered a lake. Silver and Pyramid lakes also have a stocking history (they are currently fishless) but are not part of this plan/EIS because they are in one of the Research Natural Areas described earlier in this chapter.

The mountain lakes with a history of fish stocking are dotted throughout the major watersheds in the North Cascades Complex and occur at elevations ranging from about 1,350 feet above mean sea level at Thunder Lake to 6,795 feet above mean sea level at Stiletto Lake (see table 17). The mountain lakes occur in four broad vegetation zones: lowland forest, montane (high) forests, subalpine parkland, and alpine. Lakes are found in all four zones on both sides of the Cascade Crest and range in size from less than 1 acre to

TABLE 17: RANGE OF PHYSICAL ATTRIBUTES FOR MOUNTAIN LAKES WITH A HISTORY OF FISH STOCKING

	Size (acres)	Depth (feet)	Elevation (feet above mean sea level)
Mean	16	55.2	4,981
Median	5.4	25.9	5,140
Maximum	162 (Silver Lake*)	522 (Silver Lake)	6,795 (Stiletto Lake)
Minimum	0.2 (Panther Potholes, upper)	9 (Panther Potholes, upper)	1,350 (Thunder Lake)

Note:

* Silver Lake has a history of fish stocking but is now fishless. It is in a Research Natural Area and not included in this plan/EIS.

approximately 162 acres (Silver Lake). Many of the lakes in the park (64%) are less than 10 acres. There are only 9 lakes greater than 50 acres and only 3 lakes greater than 100 acres. This skewed distribution follows a similar pattern with respect to lake depth: there are only 12 lakes greater than 100 feet and only 4 lakes greater than 200 feet deep. Silver Lake is the largest (162 acres) deepest (522 feet), and nearly highest (6,700 feet above, mean sea level) lake of the mountain lakes. The attributes of the 91 lakes analyzed in this plan/EIS are presented in appendix E.

Silver Lake is classified as a cirque lake.

The mountain lakes in the North Cascades Complex are characterized by eight classes: cirque, trough, ice scour, moraine, bench, fault, slump, and kettle.

- Cirque lakes exist at the head of U-shaped glaciated (or formerly glaciated) valleys (Silver Lake is a cirque lake and, excluding Lake Chelan, the deepest in the North Cascades Complex).
- Trough lakes were formed in glacially scoured U-shaped valleys. They tend to be long, narrow, and wedge-shaped, with the deepest spots in the lakes near their outlets.
- Ice-scour lakes occur in irregular depressions and are often found on ridgetops. These lakes generally tend to be shallow.
- Moraine lakes formed behind terminal or lateral moraines that were deposited by receding glaciers.
- Bench lakes are literally found on topographic benches (relatively flat areas).
- Fault lakes were formed by bedrock dams created by differential displacement of bedrock along tectonic faults.
- Slump lakes occur in the depression left by the rotational "slip" of deep-seated soil.
- Kettle lakes were formed by depressions or "kettles" left after a glacier retreated.

Skymo Lake is classified as a moraine lake.

The lakes of the North Cascades Complex occupy a wide range of elevations, geologic terrains, and vegetation types. There are a variety of lake attributes, with large differences in shape, surface area, temperature, and depth. No two lakes are alike; each lake is a unique result of the physical, chemical, and biological processes that shaped the surrounding lake basin and the lake itself. These processes continue to unfold as glaciers melt and new lakes are born and as older lakes slowly accumulate sediment, organic matter, and woody debris. One way to measure these dynamic processes is by analyzing the water quality of the lakes.

MOUNTAIN LAKES WATER QUALITY

The term "water quality" is used to describe the physical, chemical, and biological condition of water as influenced by natural processes and human activities. There are many ways to characterize and quantify water quality, and selection of appropriate methods often depends on the intended use of the water or the water body (Novotny and Olem 1994). For lakes in the North Cascades Complex, the "intended use" of water is for maintenance of ecological functions and processes and preservation of human values such as recreation, aesthetics, and clean water for consumption. These intended uses reflect the need for water and water bodies of the highest and most unimpaired quality.

pH is the measure of the acidity or alkalinity of a solution, such as vinegar, or a damp substance, such as soil. The pH of pure water is 7, with lower numbers indicating acidity and higher numbers indicating alkalinity.

The common physical and chemical measurements of water quality include temperature, pH, alkalinity, dissolved oxygen, conductivity, and nutrients such as nitrogen and phosphorus that are important for photosynthetic organisms such plants, algae, and phytoplankton (primary producers) and for indirectly sustaining organisms at higher levels in the food chain. Approximately 105 of the lakes in the North Cascades Complex have been surveyed by park biologists and affiliated researchers for one or more parameters of baseline water quality; some lakes have been surveyed repeatedly over many years. The results of those surveys have yielded some broadly descriptive patterns and correlations with physical, chemical, and biological processes that may have important implications for mountain lakes fishery management.

Broadly speaking, lakes in the North Cascades Complex are relatively cold, neutral in pH (i.e., neither overly acidic nor alkaline), low in concentration of dissolved solids, and also low in concentration of inorganic nutrients such as phosphorus and nitrogen. Taken together, these parameters indicate that most of the lakes in the North Cascades Complex are oligotrophic or ultra-oligotrophic (Liss et al. 1995). Oligotrophic means the lakes contain relatively little plant life and nutrients but are rich in dissolved oxygen. Under these conditions, the lakes are low in productivity and capacity to sustain aquatic life through primary production (Wetzel 2001). Although lakes can be somewhat uniformly described as oligotrophic, there is a great deal of variation in water quality among the mountain lakes due to a variety of factors including geographic distribution, elevation, aspect, and morphology (shape and structure) of the lake basin.

The biological productivity of lakes in the North Cascades Complex is strongly influenced by lake elevation and basin aspect. These two factors greatly affect the length of time a given lake remains frozen each year. Low-elevation lakes have the longest ice-free periods, and high-elevation alpine lakes have the shortest ice-free periods. Some high-elevation lakes, particularly lakes with easterly or northerly exposures, may not thaw following a winter with heavy snowfall (NPS, J. Reidel, pers. comm., 2003). Most lakes, however, become ice-free by mid-July and freeze over by late October to early November. Lakes on the west side of the Cascades tend to freeze over about two weeks later than lakes on the east side. The generally short ice-free season in the North Cascades Complex has a great influence on the survival and reproductive potential of both native species and stocked fish.

Water quality parameters (water temperature, pH, alkalinity, conductivity, total Kjeldahl nitrogen (TKN), ammonia nitrogen, and total phosphorus) tend to decline at higher elevations, but nitrogen, in the form of nitrates, increases in concentration at higher elevations. Lakes with a strong glacial influence contain higher levels of phosphorus. Lake depth also appears to have some influence on water quality; for example, concentrations of alkalinity, conductivity, TKN, and total phosphorus appear to be higher in shallow lakes (less than 32 feet deep) than in deeper lakes. Lake-basin geology does not appear to play a major role in segregating most lakes based on water quality (Liss et al. 1995), although the higher pH level of certain lakes (such as Ridley Lake with a pH of 8.3) may be related to the limestone composition of the underlying geologic terrains (for example, Hozomeen terrain).

Origin of Mountain Biota

All the mountain lakes in the North Cascades Complex were at one time fishless because of topographic barriers, such as cascades, that obstructed fish migration. Though lacking in fish, the lakes were far from barren of aquatic life. When the glaciers receded following the last ice age, a dynamic process of dispersal and colonization occurred, giving rise to a rich array of aquatic organisms that eventually colonized the mountain lakes. This process, which continues today, varied greatly among the different organisms. Most insects flew or were carried by wind to the lakes. Smaller zooplankton may have been carried on up-valley breezes (OSU, G. Larson, pers. comm., 2003). Larger species of crustacean zooplankton and amphipods may have been transported on feathers, in the digestive byproducts of waterfowl, or in fur of semi-aquatic mammals (Daborn 1976; Peck 1975). The amphibians slowly spread over land or followed watercourses. Recent genetic research (Shields and Liss 2003) indicates that long-toed salamanders may have colonized the east and west sides of the North Cascades from two separate glaciers. Over long periods of time, the lakes were colonized by a unique, fishless assemblage of aquatic and semi-aquatic organisms.

Biota: The total complement of all the animals and plants in a given area.

The following sections describe the various organisms (invertebrate and vertebrate) that researchers have found in North Cascades Complex lakes. Because it is believed that fish are not native to mountain lakes prior to their introduction by humans, this section is intended to describe the predisturbance, or historic conditions, of mountain lakes in the North Cascades Complex based on available information and professional judgment. Fish stocking has taken place now for more than a century, and it may not be possible to truly understand the pre-stocking diversity, abundance, and distribution of native species.

The term "biota" refers to the total complement of all the animals and plants in a given area.

AQUATIC ORGANISMS

INTRODUCTION

This section describes four main groups of aquatic organisms that are key components of the lake ecosystems in the North Cascades Complex.

> Plankton (free-floating microscopic plants (phytoplankton) and animals (zooplankton)
>
> Macroinvertebrates (larger invertebrate animals like worms and insects)
>
> Amphibians (frogs and salamanders)
>
> Fish

Each of these plays an important role in maintaining desirable conditions in mountain lake ecosystems and in preserving the biological resources of the lakes. A large part of an organism's importance has to do with its role in the lake food web; that is, its "trophic level" or "trophic role." This basically comes down to "who eats whom" and if there is sufficient food to support higher levels of organisms within the lake and sustain the lake's desired ecological condition. Each group of organisms also plays a role in the cycling of nutrients in the lake ecosystem by taking up and/or releasing nitrogen and phosphorus, which are needed for the production of plants that support the overall productivity of the lake. The following "Introduction to Lake Ecology" should help the reader form a basic understanding of these roles and the importance of each group of aquatic organisms.

INTRODUCTION TO LAKE ECOLOGY

How Aquatic Systems Work: Food Chains/Webs and Nutrient Cycling

The relationships between biological communities within a lake ecosystem may be organized conceptually into a food chain or, more realistically, a food web. A food chain is a simple representation of the flow of food energy from one level to another, usually starting with plants that can make food through photosynthesis, and leading up to the "top" consumer. For a mountain lake, a simple food chain might resemble something like this:

Phytoplankton → Zooplankton → Macroinvertebrates → Amphibians → Fish

Each level in the food chain is called a “trophic” level, and the plants that make the food are referred to as primary producers. Organisms further up the chain are called the consumers or predators and are often divided into those that eat plants (herbivores) or those that eat animal tissue or meat (carnivores). Generally, there are a lot more producers and lower-level consumers in a food chain, since they are needed to support larger organisms at the top—the top predators. However, in real life, many species eat a variety of organisms (omnivores) and are not necessarily tied to particular trophic level. Also, consumers often shift levels throughout their life cycle. For example, a larval fish may initially eat fine particulate material and small zooplankton, and it may then switch and graze on larger zooplankton and, ultimately, end up feeding on salamander eggs and larvae when it reaches maturity. Therefore, relationships in a mountain lake are more realistically portrayed as a food web. Figure 8 depicts the simplified food web for a typical mountain lake.

The density of plankton varies depending on the availability of nutrients and stability of the water. A liter of lake water could contain more than 500 million planktonic organisms.

The following is a summary of connections between the organisms depicted in the food web:

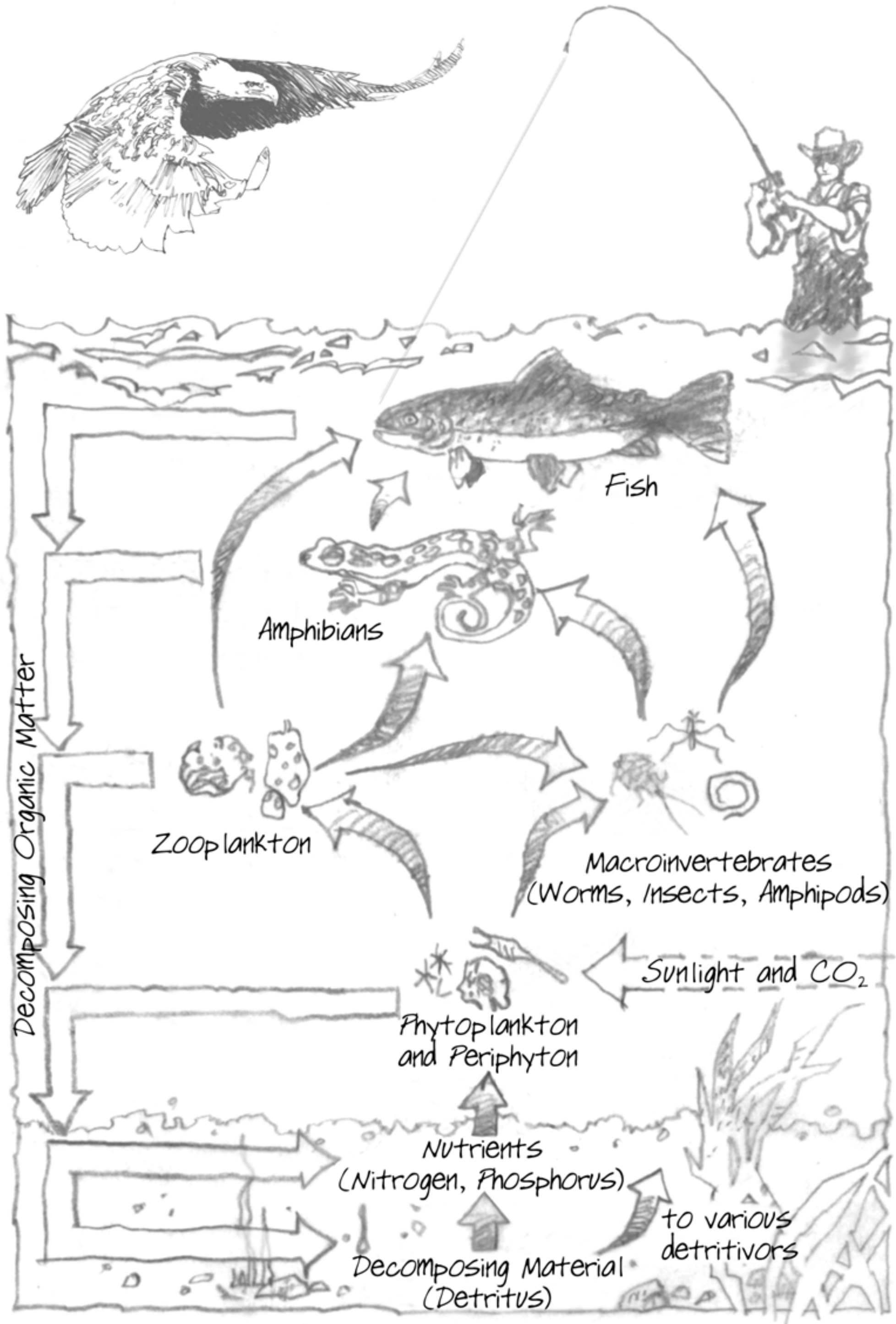
Phytoplankton—these, along with the periphyton (algae attached to rocks or other substrates) are the primary producers in a lake ecosystem and form the base of the food web. These organisms undergo a process called photosynthesis in which they take energy from sunlight and convert nonliving, inorganic material (carbon dioxide, water, and nutrients) into living, organic plant tissue. Oxygen is released as a byproduct of this process. Generally, phytoplankton are not directly affected by fish predation but are indirectly affected by changes in the food web caused by fish introduction.

Zooplankton—these include a wide variety of microscopic animals such as copepods and cladocerans. They are the first consumer level in the food web. Most grazing zooplankton species feed on phytoplankton, but some smaller ones are, in turn, preyed upon by other larger zooplankton species. Zooplankton are directly affected by fish predation and indirectly affected by changes in the food web caused by fish introduction.

Macroinvertebrates—these include organisms such as aquatic insects, snails, amphipods (scuds), and a variety of worms. These organisms primarily eat phytoplankton, periphyton, and zooplankton and may also consume detritus (decaying plants and animals) for food. Macroinvertebrates are directly affected by fish predation and indirectly affected by changes in the food web caused by fish introduction.

Amphibians—these include salamanders and frogs, which consume zooplankton and macroinvertebrates. Much of the consumption depends on the stage of the particular amphibian in its life cycle. For instance, salamander larvae consume mostly zooplankton, while adult salamanders eat larger macroinvertebrate larvae and adult insects and worms. Amphibians are directly affected by fish predation and competition for prey and indirectly affected by changes in trophic interactions and nutrient cycling caused by fish introduction.

FIGURE 8: FOOD WEB FOR A LAKE WITH FISH



Fish—these include many stocked and introduced species. Juvenile fish feed primarily on zooplankton and the smaller macroinvertebrates, while adult fish may eat larger zooplankton, macroinvertebrates, and amphibian larvae. Native fish are directly affected by predation by introduced fish species, competition for habitat and prey, and in some cases, hybridization (interbreeding).

Humans, bears, eagles, and other large predators—although not directly part of the aquatic food web, these are the top predators in the entire lake system of the North Cascades Complex when fish are available.

As shown on figure 8, nutrients are also part of the picture, and they cycle through the system. Nutrients, such as nitrogen and phosphorus, are needed for plant production and the overall productivity of a lake. When organisms die, nutrients contained in the decaying organic matter (called detritus) are released as this material decomposes. Nitrogen, in particular, is also contained in wastes excreted by organisms (fish excrete quite a bit more nitrogen than others, given their size). Just like houseplants, phytoplankton use these nutrients to grow and develop. The more nutrients, the more phytoplankton can grow to support upper trophic levels, and the more productive the lake. On the other hand, an abundance of nutrients in a lake can cause an unusual increase in the amount of phytoplankton that develops.

It is important to discuss and analyze these organisms in this plan/EIS because they serve as vital links that ensure the stability and biological resources of the ecosystem. If a particular species is reduced or eliminated from the food web, other organisms in the system are affected, just like breaking a strand in a web will put new stresses on the remaining strands and change the structural stability of the web. The concern about stocked fish to a naturally fishless lake comes from the potential effects on the trophic relationships and the nutrient balance in the lake (in other words, potential changes in the food web). For example, certain stocked fish may eat a large quantity of zooplankton, which can reduce the amount of food available to other organisms (such as some macroinvertebrates) that depend on zooplankton for their food supply. Also, with fewer zooplankton, certain species of smaller zooplankton or phytoplankton may increase. Fish also add nutrients through their waste elimination, and this could add to the increase in phytoplankton or other producers as more nitrogen is available. All these shifts and changes can cause an imbalance in the normal functioning of the ecosystem, and in some cases, important links in the food chain or sensitive species could actually be eliminated.

How Organisms Are Organized: Ecosystems, Communities, Populations, and Metapopulations

Another way aquatic organisms are organized is by their relationship with other species and their environment. In this case, we are not talking about trophic levels, but rather the different levels of organisms as defined by their genetic connections and their connections with the other components of their environment. In general, from smaller to larger, there is a “biological spectrum” that can be depicted as

Genes → Cells → Organs → Organisms → Populations → Communities → Ecosystems

In the analysis provided in the "Environmental Consequences" chapter, the focus is mainly on impacts at the population and community levels, which have implications at the ecosystem level. A population (sometimes called "species population") is a collective group of organisms of the same species occupying a particular geographic space. For example, the analysis may discuss a population of long-toed salamanders or a population of certain species of phytoplankton in a lake.

A community is any group of populations living in a certain geographic area or physical habitat. For example, the phytoplankton community consists of all the different species of phytoplankton in a lake. In some cases, the extent of geographic distribution is best described as a cluster of geographically discrete (separate) populations that are connected by infrequent, but critical, interbreeding. This is then referred to as a metapopulation. For example, the geographic extent of a population of aquatic macroinvertebrates with a flying adult phase, such as caddisflies, is generally determined by drainage basin boundaries. Adult caddisflies from one population may frequently disperse to other drainage basins and interbreed with other populations, forming a metapopulation relationship. This is important because metapopulation relationships allow for recolonization of suitable habitats where populations, for some reason, are no longer present.

Finally, an ecosystem includes both the living and nonliving components in an area—the organisms and their physical environment, which includes the soil, sediments, air, and water they use and live in.

PLANKTONIC ORGANISMS

Planktonic or "free-floating" organisms can be found in lakes throughout the North Cascades Complex. These organisms include phytoplankton, which are free-floating microscopic plants, and zooplankton, their animal counterparts.

PHYTOPLANKTON

Phytoplankton are tiny photosynthetic plants that float within the water column. The phytoplankton community in mountain lakes consists of many different types of microscopic and submicroscopic organisms that include diatoms, blue-green algae, green algae, and photosynthetic flagellates (Reid and Wood 1976). Just like other algae or land-based plants, phytoplankton transform sunlight and carbon dioxide into organic tissue through photosynthesis and are, therefore, considered "primary producers." When phytoplankton die (or are consumed), they become organic matter or food that is available for organisms at higher levels in a lake's food web. Because they are the first link in the aquatic food web, phytoplankton are vital components of the lake ecosystems of the North Cascades Complex.

Diatoms are single-celled algae with a cell wall made of silica.

Flagellates, like diatoms, are phytoplankton responsible for producing energy and forming the base of the aquatic food chain.

As discussed previously in the section titled "Mountain Lake Water Quality," the water quality of the lakes is influenced by such factors as lake elevation and temperature, the concentration of dissolved solids, total Kjeldahl nitrogen (TKN), and water temperature increases relative to decreasing lake elevation. The physical and chemical characteristics of lakes tend to change with changes in elevation. Phytoplankton densities and productivity tend to increase with decreasing lake elevation and associated changes in water quality. The lower the elevation and higher the water temperature of a lake, the more likely it is to have higher levels of dissolved solids and TKN, an indicator of the potential for plant growth and lake productivity (Larson et al. 1999b). The density of phytoplankton, which is a large part of the measured productivity of a lake, also increases along this same gradient; that is, it is higher in low-elevation warmer lakes with high levels of dissolved solids and TKN (Larson et al. 1998). The productivity and diversity of phytoplankton also tend to increase with increasing amounts of the nutrient phosphorus in lakes (Larson et al. 1998).

As mentioned previously, phytoplankton are at the base of the aquatic food web of mountain lakes. Top predators in North Cascades Complex lakes, such as salamanders and fish, do not feed on the tiny phytoplankton. It is the zooplankton and other invertebrates that feed on phytoplankton, and they in turn, are consumed by larger animals such as fish and salamanders. Fish stocking, however, can disrupt the natural balance of the density and species of phytoplankton that would usually occur in fishless lakes. Zooplankton that would normally graze on phytoplankton may be consumed by fish, resulting in higher densities of phytoplankton or a particular species of phytoplankton. Fish waste products may increase nutrient levels and cause changes in phytoplankton populations outside the normal range of variability.

ZOOPLANKTON

Zooplankton are microscopic animals that are free-floating in the water column. They include a wide variety of organisms, including protozoans, rotifers, and crustacean zooplankton. Protozoans are one-celled plankton that include ciliates (those with cilia, or small hair-like projections) and flagellates (those with whip-like projections). Rotifers have retractable crowns of cilia that create currents to draw in food. They are widely distributed in the lakes of the North Cascades Complex and may be the dominant zooplankton under certain conditions. The crustacean zooplankton community includes cladocerans and copepods.

Cladocerans, commonly called "water fleas," are small, generally transparent crustaceans that feed on small organic particles. *Daphnia* are the most commonly known genus of cladoceran. These small herbivorous (plant-eating) zooplankton are often referred to as the "cattle" of lakes and ponds because they graze primarily on phytoplankton. In contrast to the flat disc-like shape of cladocerans, copepods are a type of crustacean zooplankton with a cylindrical and segmented shape. Copepods exhibit a wide variety of feeding preferences, even consuming other zooplanktonic organisms. In the food web of mountain lakes, the larger cladocerans and copepods are a very important component of the food base for larger vertebrate organisms such as larval amphibians and fish (Wetzel 2001; Brönmark and Hansson 1998).

The crustacean zooplankton communities in lakes of the North Cascades Complex are very diverse, and more detail about their ecology can be found in documents that are posted on the website developed for this plan/EIS (http://www.nps.gov/npca/highlakes.htm). This research, which is summarized in the "Purpose of and Need for Action" chapter, indicates that zooplankton are found in all 91 lakes addressed in this document, including the lakes with fish. Five species of diaptomid zooplankton inhabit the lakes in the North Cascades Complex: *Diaptomus kenai, D. articus, D. tyrelli, D. lintoni*, and *D. leptopus*. The most common large diaptomid, *D. kenai*, is able to persist over a wide range of conditions—even conditions that would not be expected to support living organisms (Liss et al. 1998). The densities of zooplankton are not known for all the lakes in the North Cascades Complex, but results from the study of a subset of lakes indicate that the densities of copepods are affected by temperature, nutrient levels, and especially, fish predation. In general, much of the research indicates that high densities of fish, especially reproducing fish that can build up to very high densities and form multiple age classes over time, can cause a substantial decrease in the density of certain large copepods due to predation (Liss et al. 1998). Lower densities of fish, more typical of stocked situations, do not have as great an effect. There is not much difference in abundance of diaptomid copepods between these stocked lakes and fishless lakes (Liss et al. 1998), possibly because the densities are not as high in stocked lakes, and the zooplankton can recover between stockings.

Five species of diaptomid zooplankton inhabit the lakes in the North Cascades Complex.

In addition, it was found that copepods are more abundant in deeper lakes with high fish densities than in shallower lakes with high fish densities because it is thought that the zooplankton use the deeper waters to escape predation (Liss et al. 1998). For herbivorous copepods, the nutrient level of a lake is also important. The small herbivorous copepod, *L. tyrelli*, is restricted to shallow lakes (less than 32 feet deep) with relatively high concentrations of TKN and total phosphorus. Also, some smaller herbivorous copepods serve as food for the larger zooplankton, and the smaller copepods may flourish when a lake is stocked and fish eat many of the larger zooplankton (Liss et al. 1998).

MACROINVERTEBRATES

The term "macroinvertebrate" is often used generically to describe a diverse array of aquatic invertebrate organisms that are large enough to be seen clearly with the naked eye. Many larval and adult macroinvertebrates (such as *Chaoborus*, a phantom midge) in lake ecosystems are also planktonic or free-floating, so the distinction between planktonic organisms and macroinvertebrates in this discussion is useful but somewhat arbitrary.

Research into the ecology and numbers of macroinvertebrates in the lakes of the North Cascades Complex has focused largely on the nearshore macroinvertebrates, primarily because of the logistical limitations of sampling deeper water. Also, predators, such as salamanders and fish, are known to feed selectively on macroinvertebrates in the shallow nearshore areas of lakes.

The recent research into the ecological effects of stocked fish in the lakes of the North Cascades Complex (Liss et al. 1995) found 88 nearshore classifications of

The term "macroinvertebrate" is often used generically to describe a diverse array of aquatic invertebrate organisms that are large enough to be seen clearly with the naked eye.

macroinvertebrates, representing 16 distinct taxonomic groups including aquatic insects, gastropods (snails), amphipods (scuds or sandhoppers), nematodes (unsegmented worms), oligochaetes (segmented worms), and turbellaria (flatworms). The presence of nearshore macroinvertebrates in lakes in the North Cascades Complex is associated with habitat and food availability, plus lake water temperature and elevation (Hoffman et al. 1996). In general, higher elevation lakes, which are colder and have less nearshore vegetation and food availability, contain fewer types of macroinvertebrates. Research found that 83% of different taxonomic groups inhabit lower-elevation forest-zone lakes, 61% inhabit subalpine lakes, and only 16% inhabit higher alpine lakes (Hoffman et al. 1996).

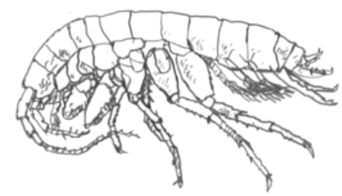
Macroinvertebrates are a very important food source for salamander larvae and fish, the two top vertebrate predators in lakes in the North Cascades Complex (Tyler et al. 1998a; Liss et al. 1995). When lakes with vertebrate predators were compared to lakes without vertebrate predators, statistically significant differences were found in the abundance of three types of aquatic insects: a stonefly (*Taenionema*), a mayfly (*Ameletus*), and a caddisfly (*Desmona mono*). The larval stonefly was far less abundant in lakes with vertebrate predators, though the role of fish predation in reducing its abundance could not be determined. The mayfly was found almost exclusively in lakes without salamanders or fish, but salamander predation, not fish predation, appeared to limit its distribution. Only the caddisfly appeared to be limited by fish predation (Liss et al. 1995).

The caddisfly is an herbivore (feeds on plants) and detritivore (feeds on decaying plant or animal material) that is commonly found throughout the western United States, particularly in stream habitats (Merrit and Cummins 1996). In the North Cascades Complex, the caddisfly, *D. mono*, is found in lakes on both sides of the Cascade Crest, but it is more common in subalpine lakes than forested lakes (Liss et al. 1995).

As part of a program for long-term monitoring of aquatic resources in the North Cascades Complex, NPS biologists have been collecting nearshore benthic macroinvertebrates (those that live on lake bottoms) to identify long-term trends in the biological resources of lakes and streams. Benthic macroinvertebrates are especially suited for long-term monitoring of ecosystem health because they are widely distributed, and certain taxa are quite sensitive to pollution and other human-caused stresses. The benthic macroinvertebrate monitoring has detected *D. mono* in over 50 of 88 surveyed lakes in the North Cascades Complex, indicating that the species is a common and widely distributed taxon, primarily in lakes without fish.

Amphipods are laterally compressed crustaceans in the order Amphipoda; they resemble tiny shrimp. More commonly called "scuds" or "sandhoppers," they can be a very important food source for fish in freshwater habitats (Reid and Wood 1976; Brönmark and Hansson 1998). Three kinds of amphipods (*Stygobromus* sp., *Gammarus lacustris*, and *Hyalella azteca*) have been collected in about 10 lakes (including Hozomeen Lake) in the North Cascades Complex.

Recent sampling of benthic macroinvertebrates in fishless lakes led to the discovery of an unusual genus of blind amphipod not previously found in the Pacific Northwest. The blind amphipod, belonging to the genus *Stygobromus*, was collected from two relatively shallow lakes: Redoubt Lake (maximum depth—46 feet) and Upper East Lake (maximum depth—unknown). Redoubt Lake was last stocked with fish in 1967 but has since become fishless. This finding was an interesting new record for the western United States since the only other known taxon in the genus *Stygobromus* was collected from very deep water in Lake Tahoe, California. According to the taxonomist who identified the amphipod, it is unusual that a blind amphipod would be found in such shallow water (ODU, J. Holsinger, pers. comm., 2001).



The "blind amphipod" was found in water samples taken from Redoubt Lake and Upper East Lake.

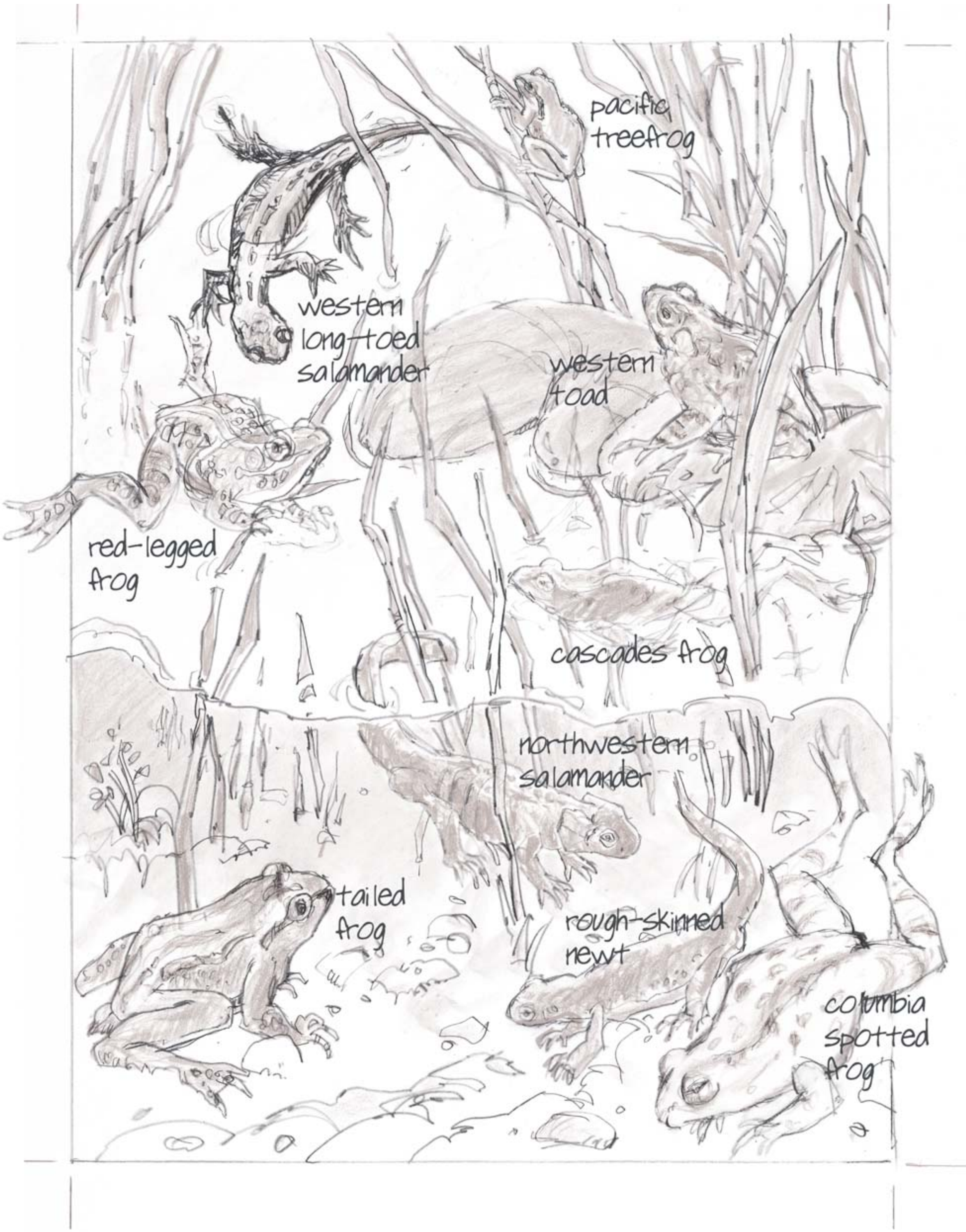
AMPHIBIANS

Of the 12 species of amphibians in the North Cascades Complex, 9 are believed to inhabit lakes and ponds or associated outlet streams and wet meadows; there are 2 species of salamander, 1 newt, 5 species of frog, and 1 species of toad. The highest diversity of amphibian species appears to be in the Big Beaver drainage on the west side of Ross Lake. This large drainage is relatively low in elevation and has an abundance of water resources such as creeks, beaver ponds, forested and scrub shrub wetlands, and seeps. The following section describes the range, habitat, and abundance (if known) of four of the amphibian species that inhabit or breed in lakes in the North Cascades Complex. Five more amphibian species are discussed under the section titled "Special Status Species" in this chapter.

LONG-TOED SALAMANDER

The long-toed salamander (*Ambystoma macrodactylum*) is widely distributed throughout the Pacific Northwest (Leonard et al. 1993) and in the North Cascades Complex (Liss et al. 1995; Bury et al. 2000). Research in the North Cascades Complex has documented larvae in a wide variety of watery habitats, ranging from shallow ponds to deep lakes. Adult long-toed salamanders are fossorial (terrestrial animals that live underground in burrows). They are not capable of creating their own burrows but depend on small mammal burrows for habitat and dispersal (Petranka 1998; Semlitsch 1983). In the fishless high-elevation mountain lakes of the North Cascades Complex, long-toed salamanders are considered the top vertebrate predator (Tyler et al. 1998a). The long-toed salamander is an important species to examine in this plan/EIS because it has been shown to be sensitive to nonnative fish predation in several studies conducted in mountain lakes in western North America (Dunham et al. 2004).

"Table G-4: Assessment of Impacts on Amphibians" (see appendix G) lists those lakes that were found to have either long-toed or Northwestern salamanders present or likely to be present, based on recent research completed in the North Cascades Complex. Of the 91 lakes in the study area, 40 are likely to have long-toed salamanders present, based on suitable habitat and known ranges, and 32 lakes have had long-toed salamander presence documented by surveys. Long-toed salamanders are found on both the west and east sides of the Cascade Crest; however, on the east side, the larvae appear to be more abundant in smaller, shallower lakes (Liss et al. 1995).


pacific treefrog
western long-toed salamander
western toad
red-legged frog
cascades frog
northwestern salamander
tailed frog
rough-skinned newt
columbia spotted frog

Two subspecies of long-toed salamanders occur in the North Cascades Complex. The distribution of the eastern long-toed salamander (*A. m. columbianum*) is east of the Cascade Crest in the Lake Chelan and Stehekin River drainages, as far upstream as the junction of Bridge Creek (including Bridge Creek to its headwaters). The western long-toed salamander (*A.m. macrodatylum*) is distributed west of the Cascade Crest in the drainages of the Skagit, Baker, and Chilliwack rivers. The western subspecies appears to be absent from much of the center of the North Unit of North Cascades National Park, and both subspecies appear to be absent in most of the South Unit, with most of the eastern long-toed salamanders documented in the Lake Chelan National Recreation Area. This distribution is consistent with long-toed salamanders recolonizing lower-gradient streams and rivers that have deep glacial sediments and avoiding the least productive lakes in the central regions of both the North and South Units.

The findings of the research conducted in the North Cascades Complex regarding effects of fish and other parameters on salamanders are summarized in the "Purpose of and Need for Action" chapter. In general, the research indicates that there are far fewer long-toed salamanders in lakes and ponds that contain fish (especially reproducing fish), compared to lakes and ponds that are fishless, although the variation in abundance can be high even within a lake. For example, recent surveys for long-toed salamanders in eight randomly selected fishless lakes found between 0 to 65 individuals per 328 feet of shoreline surveyed (Liss et al. 2002). In the early 1990s, researchers documented 2 to 170 individuals per 328 feet of shoreline at six lakes with no fish present at the time of the survey (2 had been previously stocked). In contrast, in seven lakes containing fish that were either nonreproducing stocked (2 lakes) or reproducing (5 lakes), the range was drastically lower: 0 to 8 individuals per 328 feet of shoreline surveyed. The presence of salamanders in lakes with fish may be due to their ability to persist in areas that are unfavorable or unsuitable for fish, such as in shallow areas along shorelines with rocks and woody debris where they can hide under and escape predation.

Although fish predation appears to be a primary factor affecting salamander densities in mountain lakes, there are other factors that influence the presence and abundance of larval long-toed salamanders. Some important environmental factors may include elevation, area, water depth, temperature, and certain water quality parameters (Liss et al. 1995). Another important factor is the distribution of the species within the region, especially the availability of nearby source populations that can serve to recolonize individual lakes where local populations of salamanders are no longer present.

One particular parameter that appears to be related to the abundance of long-toed salamander larvae in North Cascades Complex lakes is TKN (Tyler et al. 1998a), which is a combined measurement of ammonia and organic nitrogen. Nitrogen is a nutrient needed for production of organic matter by plants (phytoplankton and periphyton in the lakes), which are the first link in the aquatic food web and thereby, form the basis for the overall productivity of the lake. Researchers have found that the density of larval long-toed salamanders increases with increased concentration of TKN (Tyler et al. 1998a). In practical terms, this can be explained by the links in the food web. Long-toed salamander larvae feed on a variety of cladoceran zooplankton. Lakes with more nitrogen generally support more phytoplankton, which are the food for the cladoceran zooplankton, which in turn supply more food to support larger numbers of salamanders. Therefore, lakes with high TKN and associated high productivity, especially smaller lakes that do not have fish and often not stocked, provide particularly important habitat for long-toed salamander larvae.

Very recent research into the genetic population structure of long-toed salamanders in the North Cascades Complex has uncovered a high degree of genetic diversity between local populations and populations separated by distances. Genetic isolation appears to increase with distance, and genetic exchange among separate populations is very low. This research found no significant loss of genetic diversity due to fish presence, and it underscores the importance of maintaining metapopulations by protecting lakes that are geographically isolated.

NORTHWESTERN SALAMANDER

The Northwestern salamander (*Ambystoma gracile*) belongs to the same genus as the long-toed salamander. It is secretive and rarely seen except during the breeding season. Terrestrial adults, like the adults of long-toed salamanders, are fossorial and generally only come to the surface at night during rainstorms, primarily when migrating to and from breeding sites. Mountain populations are often neotenic, which means that juvenile characteristics are retained in the adult. Salamanders in this “arrested” form of development fail to change (metamorphose) from the larval form to terrestrial adults, but instead become sexually mature and reproduce while retaining larval features such as gills. Experts believe the neotenic phase may help Northwestern salamanders survive drought and other environmental stresses that often kill terrestrial salamander adults.

Unlike long-toed salamanders, which can metamorphose during their first summer in shallow temporary ponds, Northwestern salamanders require at least two years in the larval stage before metamorphosing into terrestrial adults or maturing into neotenic aquatic adults. A perennial waterbody is required for breeding and rearing of larvae and neotenic adults. Breeding female Northwestern salamanders attach large, firm egg masses to sturdy support structures, frequently attaching the egg masses 1–3 feet below the water surface (Licht 1975). In lakes or ponds that experience large fluctuations in water levels, egg masses can be exposed and then dry up or freeze, thus killing most of the developing larvae.

Some authorities recognize two subspecies of the Northwestern salamander, but the current consensus is against any subspecies divisions. The mountainous habitats of the North Cascades Complex are near the elevational range limit of the Northwestern salamander, and this may explain why they appear to be restricted to lower elevations on the west side of the Cascade Crest. Table G-4 lists those lakes where Northwestern salamanders are present, or likely to be present, based on the recent research completed in the North Cascades Complex. As can be seen in table G-4, there are eight lakes that have suitable habitat for

Northwestern salamanders, and all eight have had the presence of these salamanders documented by surveys.

Northwestern salamanders and long-toed salamanders rarely co-exist on the west side of the Cascade Crest, and long-toed salamanders appear to be excluded from larger, deeper lakes and ponds by Northwestern salamander neotenes. Northwestern salamanders typically inhabit larger, deeper lakes and ponds with plenty of coarse wood and relatively soft, flocculent (fluffy) bottoms (Hoffman et al. 2003). Northwestern salamander presence is also strongly associated with the presence of emergent vegetation (Adams et al. 2000). When Northwestern salamanders are present, the long-toed salamanders inhabit the smaller, shallower lakes and ponds with plenty of aquatic vegetation and relatively hard bottoms. Long-toed salamander breeding sites in deeper lakes in the North Cascades Complex are typically in open areas close to subalpine forest, while Northwestern salamander breeding sites typically occur in forested areas at least 1,000 feet below the treeline. In the one recorded instance of the two species occupying the same lake in the North Cascades Complex (Diobsud No. 1), Northwestern salamander larvae are the dominant species in the main body of the lake (located in subalpine forest near the treeline), with a few long-toed salamander larvae occasionally observed. Most of the long-toed salamander larvae in this lake are found in shallow pools of the outlet stream near the lake, where there are few predatory fish or Northwestern salamanders.

Emergent vegetation has roots underwater, but upper parts above the water.

All of the populations of Northwestern salamander documented in the North Cascades Complex occur in tributary lakes of the Skagit River and Ross Lake and some of the larger tributary streams. Within this limited range, Northwestern and long-toed salamander populations occur in approximately equal numbers. Although both species occur in tributaries of the Skagit River and Ross Lake, Northwestern salamanders appear to be unsuccessful in colonizing subalpine and alpine lakes and seldom occur above the low-forest zone.

Recent surveys of three lakes containing fish reported that Northwestern salamander abundance was in the range of 18 to 21 larvae per 328 feet of shoreline. These numbers are much higher than densities of long-toed salamander larvae in lakes with fish, and may indicate that Northwestern salamanders are more resistant than long-toed salamanders to fish predation. Northwestern salamanders secrete noxious chemicals when threatened, and when exposed to fish predation, they have the ability to alter their feeding behavior (for example, they shift to nocturnal feeding schedules). Also, adult Northwestern salamanders are too large for most fish to consume. These physical and behavioral adaptations may make them less susceptible than long-toed salamanders to fish predation (Liss et al. 1995).

OTHER AMPHIBIANS

Our greatest understanding of the ecological relationships between salamanders and fish in the North Cascades Complex is limited to the long-toed salamanders and Northwestern salamanders. There are, however, other amphibians in the North Cascades Complex whose life history and habitat requirements overlap with mountain lakes that contain fish and, therefore, could be affected by fishery management actions. Two species are described in this section. Several other amphibians are listed as species of concern or candidate species and are described in the section titled "Special Status Species" in this chapter.

ROUGH-SKINNED NEWT

The rough-skinned newt (*Taricha granulosa*) is the least abundant salamander in the North Cascades Complex. It has been documented in only two low-elevation lakes: Pyramid and Thunder (Liss et al. 1995). Like the Northwestern salamander, it appears to be at the limit of its eastern range in the North Cascades Complex. The skin secretions of the newt contain toxins that are extremely poisonous; for example, a healthy human adult could die from ingesting one rough-skinned newt (Leonard et al. 1993). In Mount Rainier National Park, newts have been found where fish are present, which indicates they are not particularly sensitive to fish predation (Tyler et al. 2003).

PACIFIC TREE FROG

Pacific tree frogs (*Pseudacras regilla*) are the most widely distributed frogs in the Pacific Northwest. Until recently, Pacific tree frogs were in the genus *Hyla* (tree frogs), but genetic studies have since confirmed they are actually part of the genus *Pseudacras* (chorus frogs) (Leonard et al. 1993). Taxonomists are currently split as to their correct classification. Searches under both Latin names indicate that Pacific tree frogs have been documented in at least 10 lakes and ponds that range in elevation from about 1,500 feet to 4,000 feet above mean sea level (Bury et al. 2000; Liss et al. 1995). Two of the lakes where they have been found, Willow Lake and Ridley Lake, also contain fish. These low-elevation lakes have abundant shoreline vegetation and extensive shallow areas that may allow the frogs to hide and escape fish predation. Also, the scientific literature indicates that Pacific tree frogs may be less sensitive to predation from other amphibians and introduced fish because they not only breed in permanent water bodies, but they also breed in ponds that regularly dry up (Leonard et al. 1993).

The Pacific tree frog is found in Willow Lake, which has many shallow areas with abundant shoreline vegetation.

The scientific literature varies in its findings about the effects of fish on the Pacific tree frog. Recent research on the impacts of nonnative fish on Pacific tree frogs in the Sierra Nevada Mountains suggests that Pacific tree frogs have declined significantly in areas with large numbers of stocked lakes as a result of fish predation on egg and larval stages (Matthews et al. 2001b). Conversely, other research into the ecological effects of fish on native biota in the North Cascades Complex did not document a link between fish and Pacific tree frog abundance. Two of the three low-elevation forested lakes that were studied, Willow Lake and Ridley Lake, contained both nonreproducing populations of fish and Pacific tree frogs (Liss et al. 1995), which may indicate that these frogs can adapt to or tolerate the presence of stocked fish. These lakes also have nearby refugia and breeding areas (small ponds, wetlands) that serve to support the frog populations in these lakes.

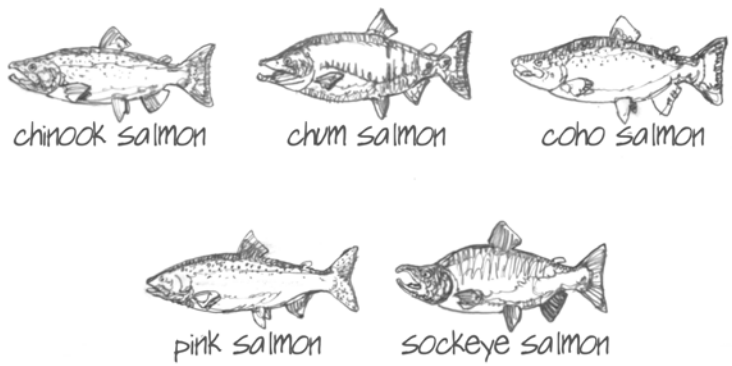
FISH

Fish in the North Cascades Complex that are addressed in this plan/EIS include two groups: (1) the native species that inhabit the mountain streams and drainages that may connect to the mountain lakes; and (2) the stocked or introduced species that are not native to the receiving lakes and that may be removed under various alternatives considered in this plan/EIS.

NATIVE FISH SPECIES

There are at least 25 native fish species that inhabit the streams and reservoirs of the North Cascades Complex (see table 18). Native fish species expected in the study area include salmon, trout, char, and mountain whitefish (family Salmonidae); minnows and dace (family Cyprinidae); suckers (family Catostomidae); sculpins (family Cottidae); and lampreys (family Petromyzontidae).

Salmon are anadromous fish, meaning they hatch in freshwater, spend a large part of their lives in the ocean, and return to freshwater to reproduce. All five Pacific salmon species (pink, sockeye, chum, Coho, and Chinook) occur in the North Cascades Complex in the Skagit River. These five species also occur in the Nooksack drainage outside the North Cascades Complex. Coho and sockeye salmon can also be found in the Chilliwack drainage in the national park. Anadromous runs of coastal cutthroat trout, bull trout, steelhead trout, and Pacific lamprey are found in the west-side drainages of the national park.



All five Pacific salmon species occur in the Skagit River within the North Cascades Complex.

Native fish populations have been affected by a variety of activities such as logging, commercial fishing, fish stocking, dams, and reservoirs. The reservoirs in the North Cascades Complex have altered and extended habitat, allowing fish migration above natural stream barriers. Prior to 1900, native anadromous and resident fish occupied primarily the low-gradient mainstream rivers and floodplain portions of their tributary streams in the North Cascades Complex. West of the Cascade Crest, native fish and char spawned and reared in steeper gradient tributaries of the mainstem rivers as far upstream as the first barrier to fish migration. In most cases these barriers were a short distance from the mainstream. In the Lake Chelan drainage, westslope cutthroat trout (*O. clarki lewisi*) were native to the Upper Stehekin River and many of its tributaries. With time, salmonid fish became established in naturally isolated tributary streams through stocking, downstream dispersal (from stocked fish populations in lakes), and from access gained by swimming around natural stream barriers when reservoirs were constructed and filled.

TABLE 18: NATIVE FISH SPECIES

Common Name	Latin Name	Native Distribution in the North Cascades Complex (Side of Cascade Crest)[a]	Basins in the North Cascades Complex[b]	Basins Downstream from the North Cascades Complex[c]
Lamprey (Petromyzontidae)				
Pacific lamprey	*Entosphenus tridentatus*	West	Skagit, Chilliwack	Nooksack, Columbia, Fraser
River lamprey[d]	*Lampetra ayresi*	West	Skagit	Nooksack, Fraser, Columbia
Western brook lamprey	*Lampetra richardsoni*	West	Skagit, Chilliwack	Nooksack, Columbia, Fraser
Sturgeon (Acipenseridae)				
White sturgeon[e]	*Acipenser transmontanus*	West[a]	Skagit	Nooksack, Columbia, Fraser
Salmon, Trout (Salmonidae)				
Pink salmon	*Oncorhynchus gorbuscha*	West	Skagit	Nooksack, Chilliwack
Chum salmon	*O. keta*	West	Skagit	Nooksack, Chilliwack, Columbia
Coho salmon	*O. kisutch*	West	Skagit, Chilliwack	Nooksack, Columbia, Fraser
Sockeye/kokanee salmon	*O. nerka*	West[b]	Skagit, Chilliwack	Columbia, Fraser
Chinook salmon[f]	*O. tshawtscha*	West[b]	Skagit	Nooksack, Chilliwack, Columbia
Coastal cutthroat trout[d]	*O. clarki clarki*	West	Skagit, Chilliwack, Nooksack	Columbia, Fraser
Westslope cutthroat trout[d]	*O. clarki lewisi*	East	Chelan	
Rainbow/steelhead trout	*O. gairdneri*	West[b]	Skagit, Chilliwack, Nooksack	Columbia, Fraser
Bull trout[g]	*Salvelinus confluentus*	West[c]	Skagit, Chilliwack	Columbia, Nooksack, Fraser
Dolly Varden	*S. malma*	West	Skagit	Nooksack, Fraser
Mountain whitefish	*Prosopium williamsoni*	West, East	Skagit, Chilliwack, Nooksack, Chelan	Fraser
Pygmy whitefish[d]	*Prosopium coulteri*	East	Chelan	
Sucker (Catostomidae)				
Longnose sucker[h]	*Catostomus catostomus*	West, East[d]	Skagit, Chelan	Nooksack, Fraser
Largescale sucker	*Catostomus macrocheilus*	West, East	Skagit, Chilliwack, Chelan	Nooksack, Fraser
Bridgelip sucker[d]	*Catostomus columbianus*	East	Chelan	
Codfish (Gadidae)				
Burbot	*Lota lota*	East	Chelan	
Sculpin (Cottidae)				
Coastrange sculpin[d]	*Cottus aleuticus*	West	Skagit, Chilliwack, Nooksack	Columbia, Fraser
Slimy sculpin	*C. cognatus*	East	Chelan	
Prickly sculpin	*C. asper*	West	Skagit, Chilliwack, Nooksack	Columbia, Fraser
Shorthead sculpin	*C. confusus*	East	Chelan	
Torrent sculpin	*C. rhotheus*	East	Chelan	

TABLE 18: NATIVE FISH SPECIES (CONTINUED)

Common Name	Latin Name	Native Distribution in the North Cascades Complex (Side of Cascade Crest)[a]	Basins in the North Cascades Complex[b]	Basins Downstream from the North Cascades Complex[c]
Minnows (Cyprinidae)				
Peamouth	*Mylocheilus caurinus*	West, East	Skagit, Chilliwack, Chelan	Nooksack, Fraser
Northern squawfish	*Ptychocheilus oregonensis*	West, East	Skagit, Chilliwack, Chelan	Nooksack, Fraser
Longnose dace[i]	*Rhinichthys cataractae*	West, East[e]	Skagit, Chelan, Nooksack	Fraser
Speckled dace[d]	*Rhinichthys osculus*	East	Chelan	
Redside shiner	*Richardsonius balteatus*	West, East	Skagit, Chilliwack, Chelan, Nooksack	Fraser
Stickleback (Gasterosteidae)				
Threespine stickleback	*Gasterosteus aculeatus*	West, East	Skagit, Chilliwack, Chelan, Nooksack	Fraser

Notes:

a. Distribution only refers to distribution within native range of species. Coastal cutthroat and rainbow that are present in the Nooksack basin within the North Cascades Complex boundaries may have been stocked but are native to watershed. Most of the Washington distributions are taken from Wydoski and Whitney (2003). Additional information on salmonid distributions is from maps in Smith (2002) and information in Cutler (2001). Additional information on distribution of fish in the Chilliwack watershed is from Scott and Crossman (1973).

b. There are four basins in the North Cascades Complex. Most of the North Cascades Complex west of the Cascade Crest is in the Skagit basin, with a small portion of the headwaters of the Nooksack River (above the range of anadromy), and portions of the upper Chilliwack River and its tributaries also occurring in the North Cascades Complex west of the Cascade Crest. The Skagit and Nooksack rivers drain into Puget Sound. The Chilliwack River drains into the Fraser River and the Straits of Georgia. All of the North Cascades Complex east of the Cascade Crest is in the Lake Chelan basin, which drains into the Columbia River.

c. This column, “Basins Downstream from the North Cascades Complex” lists areas in one of the four main basins (Nooksack, Skagit, Columbia [Chelan is a subbasin of the Columbia River], and Fraser [Chilliwack is a subbasin of the Fraser River]) downstream that have fish present that are not native to watersheds in the North Cascades Complex.

d. Represents additional species/subspecies or the common name approved by the American Fisheries Society.

e. White sturgeon do not reproduce in the Skagit River but do enter and forage in the lower (tidal portion) of the river. There are no barriers to movement in the river below Gorge Reservoir, so they may occasionally enter the portion of the Skagit River in the North Cascades Complex.

f. Chinook salmon and the landlocked form of sockeye salmon (kokanee) have been introduced into Lake Chelan but are not native to the Lake Chelan basin. Both species are native to the Columbia River above and below the confluence of the Chelan watershed with the Columbia River.

g. Bull trout are also native to the Lake Chelan basin but were gone from this watershed by the early 1960s. The U.S. Fish and Wildlife Service is considering reintroducing them.

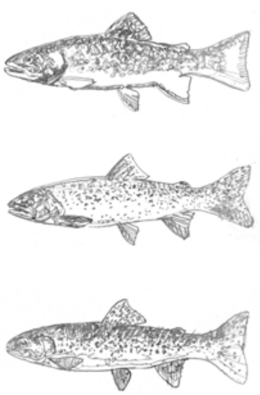
h. Populations of longnose suckers found west of the Cascade Crest in the Fraser, Skagit, and Nooksack river watersheds are morphologically different from populations in the Columbia River basin and are reproductively isolated. These fish are referred to as Salish suckers and may represent a subspecies of longnosed suckers or undescribed species.

i. Populations of longnose dace found west of the Cascade Crest in the Fraser, Skagit, and Nooksack river watersheds are morphologically different from populations in the Columbia River basin and are reproductively isolated. These fish are referred to as Nooksack dace and may represent a subspecies of longnosed dace or undescribed species.

Hybridization: To generate a new form of plant or animal by combining the genes of two different species.

In the early 1900s, the native fish in the Stehekin River / Lake Chelan system were bull trout, cutthroat trout, burbot, and various nongame species. A number of introduced species have since become established, including rainbow trout, brook trout, kokanee salmon, Chinook salmon, and hatchery strains of cutthroat trout. Lake trout also inhabit Lake Chelan. It is believed that bull trout no longer inhabit the Stehekin River / Lake Chelan system, and native westslope cutthroat populations have been partly compromised through hybridization with rainbow trout (see the discussion under "Special Status Species" in this chapter). In addition to the Stehekin River drainage, stocked fish populations have developed in such tributaries as the North Fork Cascade River and Thunder, Fisher, Big Beaver, Newhalem, and Ruby creeks.

The distribution of native fish species in the North Cascades Complex is not fully understood. The expansion of nonnative hatchery strains may be impacting native fish populations through interbreeding or by competition and predation. Outside of the North Cascades Complex, impacts to native fish are occurring as a result of such actions as unsustainable land use practices and commercial and sport fish harvest, which have greatly reduced native populations of Chinook salmon, Coho salmon, steelhead trout, Dolly Varden, cutthroat trout, and bull trout. The abundance of discrete populations of many of these species in the North Cascades Complex boundary is currently unknown. Dolly Varden, which are very similar in appearance to bull trout (a listed species), are found only in the Thunder Creek basin (tributary to Diablo) and tributaries to the Upper Skagit River above Ross Lake, and in other tributaries to the Nooksack that are not in the national park. Dolly Varden, therefore, would not be affected by any actions in the 91 lakes that are the subject of this plan/EIS (WDFW, M. Downen, pers. comm., 2004).



Escapement Goal: The number of returning adults needed to fully use the spawning habitat.

Over the last 30 years, Skagit River salmon stocks have been considerably impacted by loss of habitat from logging, hydropower development, agriculture, estuary degradation, and nonpoint source pollution. These stocks have also been subjected to exploitation in commercial, tribal, and sport fisheries. Chinook, sockeye, and Coho salmon have been impacted the most from these activities. For example, the Coho escapement goal (a measure of how many fish must return in order to continue reproduction and sustain the fishery) is set at 30,000 and has only been attained three times in the last 27 years. The spring Chinook escapement goal of 3,000 has only been attained two times in the last 27 years. The summer run Chinook escapement goal of 15,000 fish has been attained eight times in the last 27 years. Sockeye, which are native to the Baker River drainage and are subject to intensive management efforts by several agencies, have just recently approached the escapement goal of 3,000 fish. Some of these native fish are discussed in the section titled "Special Status Species" in this chapter.

Salmon provide an important food source for many species of wildlife and a nutrient source that contributes to the biological productivity of both aquatic and terrestrial ecosystems. The Skagit River's 300 to 500 wintering bald eagles depend largely on salmon as a food source.

NONNATIVE FISH IN MOUNTAIN LAKES

Over the years, several trout species and subspecies have been stocked in lakes in the North Cascades Complex, and six of these have become established as reproducing populations.

California golden trout (*Oncorhynchus mykiss aguabonita*)

Coastal cutthroat trout (*Oncorhynchus clarki clarki*)

Westslope cutthroat trout (*Oncorhynchus clarki lewisi*)

Rainbow trout (*Oncorhynchus mykiss*)

Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*)

Brook trout (*Salvelinus fontinalis*)

The Yellowstone cutthroat trout and brook trout are not considered in this plan/EIS for future stocking because neither fish is native to the area. Also, brook trout tend to overpopulate lakes in which they are stocked because of their ability to spawn successfully on lake bottoms, not just in the gravel bottoms of outlet or inlet streams (Behnke 2002). Brook trout have been stocked in at least four lakes in the North Cascades Complex over the years and have survived as reproducing populations in three lakes: Blum (Lower/West No. 4), Hozomeen, and Sourdough. Brook trout in Hozomeen Lake are known to be dispersing downstream into native bull trout habitat, although hybridization has not yet been documented. Ipsoot Lake has the only remaining reproducing population of Yellowstone cutthroat trout.

Research into the ecological impacts of nonnative fish has demonstrated that high densities of reproducing stocked fish have the greatest impacts on native species (Liss et al. 2002; Tyler et al. 1998a, b). High densities of fish can result from excessive stocking densities or from natural reproduction when conditions are suitable for spawning (such as the presence of inlets and streams). There are 37 lakes in the North Cascades Complex with reproducing populations of stocked fish, primarily various strains of rainbow and cutthroat trout. In most of these lakes, the stocked fish have the ability to dominate many trophic levels and have developed high densities.

Table 6 in the "Alternatives" chapter lists the 62 lakes in the North Cascades Complex managed by the Washington Department of Fish and Wildlife (WDFW) that are known to contain fish, the reproducing fish species currently present in 35 of these lakes, and the species and strains of fish to be stocked under one of the proposed new management frameworks presented in the "Alternatives" chapter. A description of the species and strains of fish in the current stocking program is provided in the following sections.

California Golden Trout

All California golden trout outside of California are derived from a single population in Golden Trout Creek in the upper Kern River drainage and transplanted around 1872 to Mulkey Creek, a tributary of the South Fork of the Kern River (Behnke 2002). The California golden trout (*O. mykiss aquabonita*), along with Little Kern River golden trout (*O. mykiss whitei*) and Kern River rainbow trout (*O. mykiss gilberti*), is one of three closely related subspecies of redband rainbow trout native to the Kern River basin of California (Behnke 2002). California golden trout are occasionally confused with Mexican golden trout (*O. chrysogaster*), a separate species, and West Virginia centennial golden trout, a highly colored hatchery strain of rainbow trout (*O. mykiss*). Neither of these fish is stocked in Washington. California golden trout are known to have been stocked in six lakes in the North Cascades Complex in the past, and California golden trout are on the current stocking list for four lakes: Middle Thornton, Triumph, Upper Bouck, and Hidden.

California golden trout exhibit excellent growth and survival in mountain lake habitat, and in Washington, they tend not to reproduce excessively or disperse downstream from mountain lakes. Golden trout can successfully reproduce in lakes in Washington State, but reproduction levels are not high enough to sustain populations without periodic stocking (WDFW 2001). In addition, their beautiful and distinctive coloration makes them highly sought after by anglers.

*Coastal Cutthroat Trout **(Lake Whatcom Strain)***

A Lake Whatcom strain of cutthroat trout is stocked in Willow Lake.

Coastal cutthroat trout are native throughout many Pacific Coast drainages from Prince William Sound, Alaska, to the Eel River in northern California, including on the west side of the Cascade Crest in the study area. Interior strains of cutthroat trout are preferred by many fishery biologists for stocking mountain lakes because of their ability to survive and grow rapidly in cold, short, ice-free seasons and low-nutrient environments. Currently, the Lake Whatcom strain of cutthroat trout is being stocked. This is a hatchery strain of coastal cutthroat trout (*Oncorhynchus clarki clarki*) that originated from broodstock collected in Whatcom Lake, Washington. The broodstock is currently being maintained at the Eells Springs Hatchery where eggs are collected and fertilized for shipments to local hatcheries for hatching and rearing, prior to stocking in mountain lakes. This strain of coastal cutthroat trout is currently on the proposed stocking list for four lakes: Copper, Panther Potholes (Lower), Willow, and Stout.

Lake Whatcom strain coastal cutthroat trout were selected to diversify the fishing opportunity for mountain lake anglers and add a variety of fish that are native to the Skagit River drainage. They are also proposed for stocking in Stout Lake, which has a nonnative reproducing population of westslope cutthroat trout, in the hope that they would replace, in time, the westslope cutthroat trout population or reduce the proportion of westslope cutthroat genes in the reproducing population, thereby producing a stock of fish with the phenotype of coastal cutthroat trout (WDFW 2003).

Westslope Cutthroat Trout (Twin Lakes)

Twin Lakes cutthroat trout are a wild broodstock of westslope cutthroat trout (*O. clarki lewisi*) proposed for stocking at Coon Lake. This stock of cutthroat is currently hatched and reared at the WDFW Chelan Hatchery for stocking in several North Cascades Complex lakes within the Lake Chelan drainage where westslope cutthroat trout are native. It is unclear when these lakes were first stocked with westslope cutthroat trout (Crawford 1979).

The common name for this subspecies in scientific literature is “westslope cutthroat trout,” and this is the common name used in most literature and by the U.S. Fish and Wildlife Service in referring to this subspecies. This name was applied because it was originally believed to be native only to the west side of the Rocky Mountains. It is also referred to as “intermountain cutthroat” (WDFW 2003) because it is typically found between the crest of the Cascades and the crest of the Rockies. This subspecies, however, is also the native cutthroat trout of the east side of the Rocky Mountains north of the Yellowstone River drainage (Behnke 1992).

Rainbow ***Trout***
(Ross Lake and Mt. Whitney Strains)

Rainbow trout have a native range along the Pacific slope from the Kuskokwim River, Alaska; to approximately the Rio Santa Domingo, Baja California; and east to the upper Mackenzie River drainage (Arctic Basin), Alberta and British Columbia; and lower-elevation basins of southern Oregon (Page and Burr 1991; Behnke 2002). Rainbow trout are native to the lower elevations on the west side portions of the North Cascades, but not to the mountain lakes. There are many varieties of rainbow trout, and various hatchery strains have been stocked in a large number of lakes in the North Cascades Complex.

Ross Lake Strain—The Ross Lake strain of rainbow trout is a natural stock of resident (nonmigratory or non-anadromous) coastal rainbow trout (*O. m. irideus)* native to the upper Skagit River watershed (Ross Lake subbasin). Eggs and milt are stripped from Ross Lake rainbows at tributaries of Ross Lake and hatched and reared at the Marblemount Hatchery for stocking into the upper Skagit River basin. The Ross Lake broodstock program is mainly intended to maintain a reservoir fishery in Gorge and Diablo lakes (which are not part of the study area for this plan/EIS), but Ross Lake rainbows are also proposed for stocking into Ridley Lake, which drains into Ross Lake. Although Ross Lake rainbows are capable of reproducing in a natural environment, they are not known to be able to reproduce in Ridley Lake due to an absence of graveled tributaries, and any fish that escape downstream would be populating a basin where they are already native.

Mt. Whitney Strain—Mt. Whitney rainbow trout are designated as the proposed species to be stocked in 32 of the 38 lakes in the current program (refer to table 6 in the “Alternatives” chapter). These fish are a hatchery strain of rainbow trout originally developed at the Mt. Whitney Hatchery (California) from several subspecies of rainbow native to the state of California. Coastal (*Oncorhynchus mykiss irideus*), Sacramento River (*O. m. stonei*), and Kern River (*O. m. gilberti*) rainbow trout broodstock are likely to have been used to develop this hatchery strain of rainbow trout, and it is possible that broodstock from the Kamloops *(O. m. gairdneri*) and Klamath River (*O. m. newberrii)* rainbow trout may have contributed to its genetic makeup. Lahontan cutthroat trout *(O. clarki henshawi*) broodstock also were crossed with this stock before it was obtained from the Mt. Whitney Hatchery.

The Washington State broodstock for Mt. Whitney rainbows, currently stocked on both sides of the North Cascades, is currently housed at the Eells Springs Hatchery near Shelton, Washington, where all eggs are taken. Eggs or fry are dispersed from Eells Springs to various local hatcheries to supply fry for stocking in high lakes. The Washington broodstock was founded from a shipment of eggs obtained from the Mt. Whitney hatchery at Independence, California, in June 1962 (Crawford 1979). The Mt. Whitney hatchery strain was originally developed at the Mt. Whitney hatchery in 1940, and eggs from the original California broodstock were shipped to Washington hatcheries for planting in mountain lakes as early as 1946 (Crawford 1979; WDFW 2001). This hatchery strain of rainbow trout is currently the preferred choice of the WDFW for stocking mountain lakes because it has never been documented to reproduce in mountain lakes of Washington State (WDFW 2001). This is likely because the timing of their breeding season is too early to successfully spawn in mountain lakes (the majority of spawners become ripe in January). The nonreproductive nature of Mt. Whitney rainbows in a mountain lake environment eliminates the risk of stocked mountain lakes becoming overpopulated with stunted rainbow trout. Mt. Whitney rainbows also exhibit excellent growth and survival in mountain lake habitat and produce fry at an appropriate time for stocking in mountain lakes during their ice-free period. Other hatchery rainbow stocks (with the exception of anadromous steelhead) maintained by the WDFW are fall spawners.

Haplotype: A set of closely linked genes inherited as a unit. "Haplo" comes from the Greek word for "single."

Mt. Whitney rainbows do have the potential to reproduce in lower-elevation streams but have not been documented to establish populations from fish stocked into mountain lakes in Washington State. The haplotype of Mt. Whitney rainbow has been found in low frequency during surveys of Yellowjacket Creek, a tributary of the Cowlitz River in Washington, but no mountain lakes exist in the stream's basin (Trotter et al. 1995). Mt. Whitney rainbows are stocked in low-elevation, off-channel ponds (Yellowjacket Ponds) about a half-mile upstream from the survey collection site as "super jumbo" catchable trout. Since the Mt. Whitney rainbow haplotype was found in typical small stream trout sampled in Yellowjacket Creek (rather than "super jumbo" sized fish), it is likely that introgression between stream-resident rainbow trout and escapees from hatchery stocks of Mt. Whitney rainbows accounts for the presence of the Mt. Whitney haplotype in Yellowjacket Creek rainbow trout. Measurable introgression between Mt. Whitney rainbow trout stocked in mountain lakes and low-elevation stream population of rainbow and cutthroat trout would probably require the colonization of higher-elevation reaches of lake outlet streams, an unlikely event considering the early spawning of Mt. Whitney rainbows. Although individual Mt. Whitney rainbows may occasionally escape mountain lakes where they have been stocked and make it far enough downstream to have suitable spawning habitat during the winter months, the level of genetic contribution to native fish populations is likely to be so slight as to be unmeasurable.

WILDLIFE

All species of terrestrial wildlife in the North Cascades Complex depend on water for various reasons and to different degrees, but only a small fraction of all wildlife species have strong links to the mountain lakes fishery or would be impacted by mountain lakes fishery management activities. This section describes a variety of birds and mammals that inhabit the forests, streams, wetlands, and meadows surrounding the mountain lakes that could be directly or indirectly affected by changes in mountain lakes fishery management actions, including changing stocking regimes, discontinuing stocking altogether, or removing fish using one of the lake treatment methods described in the "Alternatives" chapter. Many other wildlife species inhabit the North Cascades Complex but are intentionally not discussed here because they would unlikely incur impacts from fishery management activities, do not generally inhabit areas near mountain lakes, or do not depend on aquatic resources.

MAMMALS

Mule deer (*Odocoileus hemionus*) are the most numerous ungulates in the North Cascades Complex, including the blacktail subspecies, which occurs west of the Cascade Crest. Elk (*Cervus elaphus*) and moose (*Alces alces*) inhabit the North Cascades Complex in smaller numbers, though both species are considered rare visitors. It is estimated that 100–330 mountain goats (*Oreamnos americanus*) inhabit the higher elevations in the North Cascades Complex, and its populations are declining. The rate of mountain goat mortality is unknown; it is known, however, that mortalities are due to avalanches, falls, and predation (by mountain lions or golden eagles, for example), as well as stress and parasites due to extreme winter conditions.

Although well-adapted for life in rugged terrain and harsh climates, mountain goat populations are declining.

Black bears and grizzly bears inhabit the North Cascades Complex. Black bears (*Ursus americanus*) are common, but grizzlies (*Ursus arctos*) are extremely rare and unlikely to be affected by fishery management actions. Grizzly bears are a federally listed species and are addressed in the section titled "Special Status Species" in this chapter. Black bears are omnivores and eat any kind of food (plant or animal), including fish, if the opportunity presents itself. The extent to which black bears rely on fish in mountain lakes has not been studied but is thought to be rare, though they are known to feed on spawning fish in inlet or outlet streams. During one unusual instance in the mid-1990s, Willow Lake nearly dried up during an extended summer drought. The stocked fish in the lake died, and within a few days, several black bears were seen feeding on the fish carcasses.

Bobcats (*Felis rufus*) are elusive yet common in broken, rocky mountainous areas, as well as hardwood and coniferous forest. The diet of bobcats generally consists of small mammals and birds (Larrison 1976). Canada lynx (*Lynx* *canadensis*) are known to occupy areas east of the North Cascades Complex and are discussed in the section titled "Special Status Species" in this chapter.

Cyprinids: Freshwater fish of the family that includes carp and minnows, typically with rounded scales, soft fins, and toothless jaws.

Coyotes (*Canis latrans*) occupy virtually all natural habitats, but are less common in subalpine and alpine habitats (Larrison 1976). Red foxes (*Vulpes vulpes)* inhabit foothills and mountains and eat mice, insects, birds, amphibians, and reptiles.

River otters (*Lutra canadensis*) prefer low-elevation, forested habitat in rivers, ponds, and lakes, so potential habitat in the North Cascades Complex is fairly widespread. Otters are documented in many drainages throughout the North Cascades Complex, including Little Beaver Creek drainage. Otters are known to feed on game fish, such as trout, but they appear to prefer slower-moving fish such as suckers and larger cyprinids (Whitaker 1980).

Beavers (*Castor canadensis*) are widely distributed at lower elevations in the North Cascades Complex, particularly in the Big Beaver, Stehekin, Thunder, and Little Beaver valleys. Beavers eat bark, not fish (Whitaker 1980) and, therefore, have an indirect ecological relationship to stocked fish in that they create or augment water bodies at lower elevations, and these habitats often benefit a wide variety of other wildlife, including stocked and native fish.

Twelve species of bats may occur in the Cascade Mountain Range of Washington. The most common species to inhabit the North Cascades Complex are Yuma myotis (*Myotis yumanensis*) and little brown myotis (*M. lucifugus*) (Christophersen and Kuntz 2003). Long-eared bat (*Myotis evotis*) and long-legged bat (*M. volans*) have also been documented in the North Cascades Complex. Long-eared bats are most common in low- to mid-elevation forested habitats, and long-legged bats are rarely captured, with only one capture occurring in low- to mid-elevation riparian habitats (Christophersen and Kuntz 2003). Yuma myotis and long-eared bats are considered species of special concern that are most likely to occur near high mountain lakes and are discussed further in the "Special Status Species" section in this chapter. Additionally, nonlisted bat species that are closely associated with old-growth forests in the Pacific Northwest include California myotis (*Myotis californicus*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cinereus*) (NPS 1999a).

BIRDS

RAPTORS

Ospreys (*Pandion haliaetus*) are breeding residents in the North Cascades Complex, with nest sites located on Ross Lake, Diablo Lake, Lake Chelan, Thunder Creek, and the Skagit River. While some of these nests are not actively used every year, others are used annually (NPS, B. Kuntz, pers. comm., 2004). Ospreys have been observed feeding on fish at Thornton, McAlester, and Monogram lakes. The osprey at Thornton Lake may have been from the breeding pair along the Skagit River (NPS, R. Christophersen, pers. comm., 2003). The extent to which ospreys depend on the mountain lakes fishery is not known but could be quite substantial given the relatively easy opportunity to catch fish.

Red-tailed hawks (*Buteo jamaicensis*), northern harriers (*Circus cyanus*), great-horned owl (*Bubo virginianus*), barred owl (*Strix varia*), and Western screech owl (*Otus kennicottii*) inhabit the North Cascades Complex and may potentially nest in trees near the lakes. Northern goshawks (*Accipiter gentilis*) are a federal species of concern that also may nest near lakes in the North Cascades Complex; they are discussed further in the "Special Status Species" section in this chapter. Sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), golden eagle (*Aquila chrysaetos*), merlin (*Falco columbarius*), and peregrine falcons (*Falco peregrinus*) occur in the North Cascades Complex but are not directly associated with lake habitats.

Monogram Lake is one of the few lakes in the North Cascades Complex where ospreys have been observed.

Wintering bald eagles (*Haliaeetus leucocephalus*) are frequently observed in lower-elevation lakes. The bald eagle is a federally listed species and is further addressed in the "Special Status Species" section in this chapter.

WATERFOWL

Many species of waterfowl, such as ducks and geese, occupy the North Cascades Complex seasonally or in migration, but only a few of these species nest in the North Cascades Complex. Harlequin ducks are a federal species of concern that nest in the North Cascades Complex, and common loons are a sensitive species in the state of Washington; both species are discussed further in the section titled "Special Status Species" in this chapter.

Two fish-eating ducks, the common merganser (*Mergus merganser*) and hooded merganser (*Lophodytes cucullatus*), nest in and inhabit the wetlands, open water, and riverine habitats in the North Cascades Complex. Both species have been observed on Coon Lake, and common mergansers are also seen frequently along the Stehekin and Skagit rivers. There are no records of these two ducks occurring near any of the mountain lakes in the study area, although it is certainly possible that they could feed on fish in the summer months, particularly at the lower-elevation lakes.

Another duck species, Barrow's goldeneye (*Bucephala islandica*), inhabits lakes and ponds larger than two acres in high-elevation montane habitats. Barrow's goldeneye requires tree cavities for nesting, usually within 100 feet of open water. The species primarily eats insects, crayfish, some fish, blue mussels, pondweeds, and wild celery.

Mallard ducks (*Anas platyrhnchos*), wood ducks (*Aix sponsa*), and Canada geese (*Branta canadensis*) are known to nest around lakeshores in the North Cascades Complex. Wood Ducks have been observed at Coon Lake and Thunder Lake. Canada Geese nest most commonly near the head of Lake Chelan, along the shores of all the reservoirs in the North Cascades Complex, and along the lower 2–3 miles of the Stehekin River (NPS, B. Kuntz, pers. comm., 2004).

PASSERINES

Many species of songbirds are residents or nest in the North Cascades Complex and occupy areas near lake, riparian, or wetland habitats such as those found adjacent to lakes and streams. Birds known to occur in the North Cascades Complex that are dependent on riparian or lake habitats for shoreline nesting or foraging habitat are shown in table 19 (NPS 2003b).

REPTILES AND AMPHIBIANS

The common garter snake (*Thamnophis sirtalis*) and terrestrial garter snake (*T. elegans*) are found in the North Cascades Complex, but there is little information on their abundance and distribution. The terrestrial garter snake inhabits the Puget Sound trough and the east side of the Cascade Crest up to 3,000 feet in elevation. The common garter snake is abundant on both sides of the Cascades. It is found up to 2,000 feet in elevation in the Skagit River drainage and up to 4,000 feet in the Bridge Creek drainage. Both species are commonly associated with water, including ponds, wet meadows, and lakes. The terrestrial garter snake can also be found in low-elevation forests (Dvornich et al. 1997).

The common and terrestrial garter snakes consume a wide variety of prey, including invertebrates, small mammals, and amphibians. Both species are known to feed heavily on amphibians, even species such as the Western toad and rough-skinned newt that are considered unpalatable to highly toxic for most other predators. In high-elevation lakes in the Sierra Nevada Mountains, researchers have found that amphibian presence is an important biological factor in the persistence of the mountain garter snake (Matthews et al. 2001a). There are no studies, however, that document garter snake dependence on amphibians in mountain lakes in the North Cascades Complex.

Five amphibians in the North Cascades Complex are federally listed as species of concern as defined by the U.S. Fish and Wildlife Service: Cascades frog, Columbia spotted frog, tailed frog, northern red-legged frog, and Western toad. These species are discussed further in the section titled "Special Status Species" in this chapter. Other amphibian species were discussed earlier in the "Aquatic Organisms" section.

TABLE 19: PASSERINE BIRDS THAT UTILIZE RIPARIAN AREAS IN THE NORTH CASCADES COMPLEX

Common Name	Scientific Name	Common Name	Scientific Name
American dipper	*Cinclus mexicanus*	Olive-sided flycatcher	*Contopus cooperi*
Barn swallow	*Hirundo rustica*	Red-winged blackbird	*Agelaius phoeniceus*
Belted kingfisher	*Ceryle alcyon*	Swainson's thrush	*Catharus ustulatus*
Cliff swallow	*Petrochelidon pyrrhonota*	Tree swallow	*Tachycineta bicolor*
Dusky flycatcher	*Empidonax oberholseri*	Violet-green swallow	*Tachycineta thalassina*
Hammond's flycatcher	*Empidonax hammondii*	Warbling vireo	*Vireo gilvus*
Killdeer	*Charadrius vociferous*	Wilson's warbler	*Wilsonia pusilla*
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Little willow flycatcher	*Empidonax traillii brewsterii*

SPECIAL STATUS SPECIES

For the purposes of this plan/EIS, "special status species" are defined as those listed by either the U.S. Fish and Wildlife Service as endangered, threatened, candidate, or special concern; or by the state of Washington as endangered, threatened, candidate, or a sensitive species. The terms "threatened" and "endangered" generally describe the official federal status of vulnerable species in the North Cascades Complex, as defined by the *Endangered Species Act of 1973*. The term "candidate" is used officially by the U.S. Fish and Wildlife Service when describing those species for which sufficient information on biological vulnerability and threats is available to support issuance of a proposed rule to list, but rule issuance is precluded for some reason. The federal "species of concern" status is applied to those species for which listing may be warranted, but further biological research and field study are needed to clarify their conservation status.

For Washington state-listed species, animals are categorized as threatened, endangered, candidate, or sensitive by the WDFW. Rare plants are listed in one of six categories (endangered, threatened, sensitive, possibly extirpated [no longer present], review status, or watch status) by the Washington Natural Heritage Program. *NPS Management Policies* dictate that federal candidate species, species of concern, and state-listed threatened, endangered, candidate, or sensitive species be managed to the greatest extent possible as federally listed threatened or endangered species (NPS 2001a). Therefore, all of these special status species are included in this discussion.

FEDERALLY LISTED SPECIES

A consultation letter was sent to the U.S. Fish and Wildlife Service, and a reply was received on August 15, 2003 (included in appendix C). The reply included county-based listings of federally listed species in the North Cascades Complex. Based on this broad information and input from North Cascades Complex biologists, a list of those special status fish and wildlife species that could possibly occur within the boundaries of the North Cascades Complex was prepared (see appendix C, table C-1). This list was then narrowed down further to a list of those special status species that would be expected in or near lakes or in nearby forests within the study area that could be affected by actions proposed in the various alternatives. These species are listed in table 20.

There are no known species of federally listed plants in the North Cascades Complex.

CALIFORNIA WOLVERINE (FEDERAL SPECIES OF CONCERN, STATE CANDIDATE)

Wolverines are nocturnal and solitary and historically occurred in low densities. They occupy boreal forests (forests with northern temperate climates) and tundra habitats. Wolverines eat a variety of prey, including fish, but they do not rely on fish as a sole source of food. Their population size, distribution, or abundance in the North Cascades Complex is unknown.

TABLE 20: FEDERALLY LISTED SPECIAL STATUS SPECIES POTENTIALLY OCCURRING IN THE NORTH CASCADES COMPLEX

Common Name	Scientific Name	Species Status	
		Federal	State
California wolverine	*Gulo gulo luteus*	Species of Concern	Candidate
Canada lynx	*Lynx canadensis*	Threatened	Threatened
Gray wolf	*Canis lupus*	Endangered	Endangered
Grizzly bear	*Ursus arctos*	Threatened	Endangered
Pacific fisher	*Martes pennanti*	Species of Concern	Endangered
Yuma myotis (bat)	*Myotis yumanensis*	Species of Concern	
Long-eared bat	*Myotis evotis*	Species of Concern	
American peregrine falcon	*Falco peregrinus anatum*	Species of Concern	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened
Harlequin duck	*Histrionicus histrionicus*	Species of Concern	
Marbled murrelet	*Brachyramphus marmoratus*	Threatened	Threatened
Northern spotted owl	*Strix occidentalis caurina*	Threatened	Endangered
Northern goshawk	*Accipiter gentilis*	Species of Concern	Candidate
Little willow flycatcher	*Empidonax traillii brewsterii*	Species of Concern	
Olive-sided flycatcher	*Contopus borealis*	Species of Concern	
Cascades frog	*Rana cascadae*	Species of Concern	
Columbia spotted frog	*Rana luteiventris*	Species of Concern	Candidate
Northern red-legged frog	*Rana aurora aurora*	Species of Concern	
Tailed frog	*Ascaphus truei*	Species of Concern	
Western toad	*Bufo boreas*	Species of Concern	Candidate
Bull trout	*Salvelinus confluentus*	Threatened	Candidate
Chinook salmon	*Oncorhynchus tshawtscha*	Threatened	
Coho salmon	*Oncorhynchus kisutch*	Candidate	Sensitive
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	Species of Concern	

CANADA LYNX (FEDERAL THREATENED, STATE THREATENED)

Canada lynx occupy contiguous areas of spruce/fir forests. Although Canada lynx have only been documented in areas east of the North Cascades Complex, it does contain suitable habitat for the species, and therefore, lynx are likely present in the North Cascades Complex; however, lynx do not depend on fish as a source of food.

Small numbers of gray wolves may be present in the North Cascades Complex.

GRAY WOLF (FEDERAL ENDANGERED, STATE ENDANGERED)

Gray wolves occupy forested and open habitats away from human development and use. Gray wolves have been observed in several locations in the North Cascades Complex, but not since 1993. Nonetheless, wolves are likely present in the North Cascades Complex in small numbers, though that number is unknown. Gray wolves may eat fish opportunistically.

GRIZZLY BEAR (FEDERAL THREATENED, STATE ENDANGERED)

The status of the grizzly bear is unknown in the North Cascades Complex, but based on the suitability of the habitat, grizzly bears inhabit the North Cascades Complex in small numbers (NPS, R. Zipp, pers. comm., 2003). Grizzly bears are omnivores, but they occasionally eat vegetation or scavenge trash and may eat fish opportunistically.

PACIFIC FISHER (FEDERAL SPECIES OF CONCERN, STATE ENDANGERED)

Pacific fishers are rare nocturnal carnivores that have historically occurred throughout Washington in large contiguous areas of undisturbed forested habitats at elevations below 6,000 feet. The fisher's primary prey are porcupine and snowshoe hare, although they do eat smaller mammals such as shrew, squirrel, muskrat, and beaver, as well as carrion and fruit. They den in tree cavities, rotten logs, and rocky crevices.

The WDFW does not believe a viable Pacific fisher population exists in Washington, and soon, the species may no longer occur in the state (Lewis and Stinson 1998). In 1991 the U.S. Forest Service conducted extensive line-triggered camera surveys in the North Cascades, among other sites, and documented no evidence of Pacific fishers. Currently, the NPS at the North Cascades Complex is conducting a Forest Carnivore Inventory (2003-2004), and at the time of writing, no Pacific fishers have been documented (NPS, B. Kuntz, pers. comm., 2004). Several recent observations in the Bridge Creek drainage suggests that Pacific fishers could potentially be present in the North Cascades Complex in very small numbers, although that number is unknown because the species is solitary and elusive, generally avoiding large open areas.

YUMA MYOTIS (FEDERAL SPECIES OF CONCERN)

Yuma myotis is a small insect-eating bat that is closely associated with water. In a recent field survey, Yuma myotis was the most frequently captured bat species, with the majority of captures occurring in low- to mid-elevation riparian habitats (Christophersen and Kuntz 2003). The ecological relationship between introduced fish and this small bat is indirect, since both species feed on a similar food base of aquatic and terrestrial insects along riparian areas.

Yuma Myotis usually flies close to the water's surface, foraging on moths and small insects such as caddisflies and midges.

LONG-EARED BAT (FEDERAL SPECIES OF CONCERN)

Long-eared bats are insectivores and primarily inhabit mid- to low-elevation coniferous forests, but they have been captured at high-elevation sites (Bats Northwest 2004). The bats day roost in sheltered areas such as tree cavities under loose bark and rock crevices and also use these sites, as well as caves and mines, for night roosts (USGS 1995). These bats prey on insects such as beetles, moths, and flies that are gleaned from leaves in dense vegetation, but long-eared bats also forage over water (USGS 1995; Bats Northwest 2004). The U.S. Fish and Wildlife Service lists long-eared bats as a "Species of Concern" due to the lack of information on both hibernation and reproductive biology (Bats Northwest 2004).

Like Yuma myotis, long-eared bats do not have a direct ecological association with stocked lake fish. Furthermore, while long-eared bats are known to forage over water, they do not depend on aquatic habitats to catch their prey.

AMERICAN PEREGRINE FALCON (FEDERAL SPECIES OF CONCERN, STATE ENDANGERED)

Peregrine falcons occur in a variety of habitats and usually nest on cliffs in the North Cascades Complex. This raptor hunts medium-sized birds (including waterfowl) in open areas. Once listed as endangered, peregrine falcon populations have rebounded, primarily because of the ban on the use of DDT (dichlorodiphenyltrichloroethane).

BALD EAGLE (FEDERAL THREATENED)

Bald eagles primarily inhabit low-elevation riparian areas in the North Cascades Complex and have a direct ecological relationship to stocked fish. Eagles typically time their arrival to the North Cascades Complex to coincide with the fall and winter salmon runs along the Skagit River. Usually by mid-November, the Skagit River hosts 300 to 500 eagles, one of the largest wintering concentrations of bald eagles in Washington State (NPS 1999a). Monitoring records over the past 16 years show that wintering eagle populations were increasing, but recently, it appears that eagle populations may have stabilized.

A bald eagle pair has nested near the mouth of the Stehekin River since 2001, and a pair of bald eagles has been seen foraging on Ross Lake during the breeding season. Just over 1 mile west of the North Cascades Complex boundary, a bald eagle pair has nested successfully for at least the past 10 years. The extent to which bald eagles hunt for fish in mountain lakes is unknown; they most likely limit their foraging to lower-elevation lakes with long ice-free periods.

HARLEQUIN DUCK (FEDERAL SPECIES OF CONCERN)

Harlequin ducks are small diving ducks that feed primarily on aquatic invertebrates in low-gradient creeks and streams, but they also consume fish (Gough et al. 1998). These ducks are summer residents that nest on the rocky shores of low-gradient (less than 5% slopes) creeks and streams in the North Cascades Complex. Harlequin ducks arrive in early to mid-April. The males leave in late June to molt, while females and young remain through September before migrating back to the coast. The distribution of harlequins is fairly broad, and the species occurs throughout the North Cascades Complex, including the tributaries of the Skagit and Stehekin rivers. Even though they are not directly associated with mountain lakes, they may opportunistically feed on fry swimming downstream from lakes containing stocked fish.

Marbled Murrelet (Federal Threatened, State Threatened)

Marbled murrelets are small birds that winter on the Pacific Ocean and nest up to about 50 miles inland in old-growth forests in the Pacific United States. Murrelets return to the coast early in the morning to forage and return to the nest in the evening to feed their young. There have been observations of marbled murrelets near the west boundary of the North Cascades Complex, but no marbled murrelets have been documented in the North Cascades Complex. The marbled murrelet is listed as threatened at the federal and state level due to fragmentation and loss of old-growth forest nesting habitat and mortality from capture in salmon gillnets while foraging in the ocean.

Northern Spotted Owl (Federal Threatened, State Endangered)

The northern spotted owl inhabits mainly old-growth forests in the Pacific United States but also utilizes a variety of other forest types. In Washington, spotted owls primarily prey on flying squirrels, woodrats, and red tree voles (NPS, B. Kuntz, pers. comm., 2004). Approximately 20 breeding pairs of spotted owls occur in the North Cascades Complex. At least one spotted owl nest has been located within 1 mile of a lake considered in this plan/EIS, but the majority of lakes included in this plan/EIS are outside the elevational range of the northern spotted owl. The northern spotted owl is listed as endangered in the state of Washington because of extensive loss of habitat.

Northern spotted owls nest in hollowed-out cavities of very old trees. They feed on a variety of rodents.

Northern Goshawk (Federal Species of Concern)

Northern goshawks generally nest within about 650 to 980 feet of permanent water sources. They occur in mid- to high-elevation mature forests but usually prefer to nest in lower-elevation forests (Desimone and Hays 2004; Smith et al. 1997). The NPS has not documented northern goshawk nests near study area lakes, though pairs have been observed and may nest in areas near Dagger Lake (NPS, R. Zipp, pers. comm., 2004). Goshawks would more likely be found nesting near lower-elevation lakes within forested habitat. Northern goshawks are a federal species of concern due to loss of habitat.

Little Willow Flycatcher (Federal Species of Concern)

The little willow flycatcher is a subspecies of the willow flycatcher. The subspecies primarily nests and forages in dense brush in small wetlands and riparian zones within forested habitats, usually near pooled or running water (Craig and Williams 1998; WAGAP 1997). The subspecies arrives on the breeding grounds in May and June and migrates to southern Mexico and Central America in August (Craig and Williams 1998). Declines in populations are likely due to fragmentation and loss of habitat. Little willow flycatchers forage by hawking larger insects by waiting on exposed forage perches and capturing insects in flight or gleaning insects from leaves (Craig and Williams 1998). Little willow flycatchers have been documented to nest in the North Cascades Complex.

OLIVE-SIDED FLYCATCHER
(FEDERAL SPECIES OF CONCERN)

Olive-sided flycatchers inhabit burned, logged, or openings and edges of coniferous forests, such as water bodies (WAGAP 1997). Individuals perch on tops of coniferous trees or dead tree snags where they forage for large flying insects, and they are also known to nest in conifer trees in the North Cascades Complex. This species migrates to South America in August and returns between May and June. The species is declining throughout the Cascade Mountains where it was historically abundant (SAS 2002). Reasons for decline are unknown, but loss of habitat in wintering territories is suspected (SAS 2002).

CASCADES FROG
(FEDERAL SPECIES OF CONCERN)

The Cascades frog (*Rana cascadae*) is distributed in a relatively narrow band from the Cascade Mountains in northern Washington southward through Oregon to the northern edge of California. Separate populations exist in northern California and near the Washington coast.

The Cascades frog is a “mountain” frog that is generally found between 2,000 feet and 6,200 feet in elevation (Leonard et al. 1993). Populations have declined substantially in northern California and Oregon; however, no published documentation indicates Cascades frog populations are declining in Washington. Bury et al. (2000) reported only a few populations of Cascades frogs in the North Cascades Complex. The likely causes of its decline in California are habitat loss and predation by nonnative fish. Additionally, there is evidence that increased ultraviolet radiation exposure due to the depletion of atmospheric ozone may be another important factor contributing to decreasing numbers.

A survey of lakes and ponds in Olympic National Park found that Cascades frogs were abundant in all habitats, except the deeper lakes where fish were present (Adams et al. 2000) and in lakes containing Northwestern salamanders. The Cascades frog primarily inhabits small pools and streams in subalpine meadows and can also be found in bogs, ponds, small lakes, and marshy areas. They were found to be more common in ponds that had high dissolved organic carbon, which may provide some filtering of harmful ultraviolet radiation (Adams et al. 2000). Cascades frogs are also more common in lakes with emergent vegetation. The distribution of these frogs is irregular, and they are often not found in areas that appear to have suitable habitat (Leonard et al. 1993).

The Cascades frog has been documented in two ponds and one stream location in the Bridge Creek drainage. Cascades frogs have not been recently documented in larger, deeper lakes containing stocked fish, and one explanation for lack of documentation of the species in the North Cascades Complex is that it is the northern edge of the species’ range (Bury and Adams 2000).

COLUMBIA SPOTTED FROG
(FEDERAL SPECIES OF CONCERN, STATE CANDIDATE SPECIES)

The Columbia spotted frog (*Rana luteiventris*) was previously classified as *R. pretiosa*, but recent genetic analysis revealed that specimens classified as *R. pretiosa* were two distinct species geographically isolated from each other (Green et al. 1997). The Oregon spotted frog, *R. pretiosa*, does not occur in the North Cascades Complex (NPS, R. Holmes, pers. comm., 2003).

Populations of the Columbia spotted frog have declined dramatically throughout its range due to loss of wetland habitat and predation by introduced bullfrogs and nonnative fish (Leonard et al. 1993). As a result, it is listed as a federal species of concern and as a candidate for listing in Washington State.

The Columbia spotted frog is a highly aquatic species that lives in mountainous areas in or near cold, slow-moving streams, springs, marshes, ponds, and small lakes with only slight amounts of emergent vegetation (Leonard et al. 1993). In the North Cascades Complex, the Columbia spotted frog has been documented in wet meadows, seasonal streams, seeps, and various lakes and ponds at elevations ranging from 2,500 feet to 5,900 feet (Bury et al. 2000; Liss et al. 1995). Columbia spotted frogs have been documented in several beaver ponds in the Ross Lake basin and in four lakes on the east side of the Cascade Crest. Two of these east-side lakes (Dagger and McAlester) where Columbia spotted frogs have been documented have reproducing populations of stocked fish. These lakes also have extensive meandering inlet and outlet streams that may protect the frogs from predation (NPS, R. Hoffman, pers. comm., 2003).

NORTHERN RED-LEGGED FROG
(FEDERAL SPECIES OF CONCERN)

Of the two subspecies of red-legged frog, the northern red-legged frog (*Rana aurora aurora*) and the California red-legged frog (*R. aurora draytonii*), the northern red-legged frog is the only one found in the Pacific Northwest. The distribution of the subspecies ranges along the west side of the Cascade Crest from southwest British Columbia through most of Oregon and Washington, from sea level to approximately 3,800 feet in elevation, but the frog is more commonly found below 2,000 feet (Leonard et al. 1993).

The northern red-legged frog is a medium-sized frog that is well adapted to the cool, wet climate of the western region of the Pacific Northwest. Adults prefer cool, densely covered riparian areas next to streams, ponds, and lakes. The subspecies have been found up to 350 feet to 1,000 feet from the nearest water source. During warm, dry summers, some red-legged frogs move closer to water sources (Nussbaum et al. 1983). Amphibian surveys in the North Cascades Complex have documented a fairly abundant population of red-legged frog tadpoles and adults in wetlands and ponds in the Ross Lake drainage basin and along the Skagit River near Newhalem. Surveys of the Big Beaver valley in the early 1970s documented five adults near a “willow pond,” though the exact location is not known (Taber 1974).

TAILED FROG (FEDERAL SPECIES OF CONCERN)

Tailed frogs are typically found in or near cold, rocky streams.

Tailed frogs inhabit the Pacific Coast and Cascade Range from southwestern British Columbia to northern Oregon. They are typically found in or near cold, rocky streams at elevations from sea level to about 5,500 feet. In the North Cascades Complex, tailed frog tadpoles reach sexual maturity by 6 years. Tadpoles and adults have been documented in the outlets of six lakes in the North Cascades Complex, including Upper Bouck and Nert lakes, which are currently stocked (Bury et al. 2000; Liss et al. 1995). The U.S. Fish and Wildlife Service considers the tailed frog a species of concern because of declining populations.

WESTERN TOAD (FEDERAL SPECIES OF CONCERN, STATE CANDIDATE SPECIES)

Western or boreal toads are quite large and robust with dry, warty skin. Adults and tadpoles secrete a milky white poison when threatened. Western toads are widely distributed from northeast Mexico through the western United States, Canada, and southeastern Alaska. Historically, they were distributed throughout most of Washington State except for the arid portions of the Columbia River basin and plateau. Western toads have been documented from sea level to approximately 6,520 feet near Harts Pass, a few miles east of Ross Lake National Recreation Area. They are most common near marshes and small lakes (Leonard et al. 1993; Mathews 1999).

Intensive surveys of the Big Beaver valley in the early 1970s indicated that Western toads were extremely common in a variety of habitat types except rock slides (Taber 1974). More recent surveys of amphibians in North Cascades Complex lakes found the distribution of adult Western toads to be fragmented, and that they inhabit lower-elevation beaver ponds, floodplain ponds, and gravel-bar pools in the Stehekin, Skagit, and Ross basins. The species is also known to occur in foothill lakes and ponds in the Baker basin, outside the North Cascades Complex. More specific to lakes considered in this plan/EIS, Western toads occur in or near four lakes: Battalion, Lower Thornton, Trapper, and Willow (Liss et al. 1995). Tadpoles were observed at Trapper Lake. These four lakes vary in size from less than 6 acres to 146 acres; from less than 12 feet deep to 160 feet deep; and at elevations ranging from 2,854 feet to 5,343 feet. Unlike the surveys in Big Beaver valley, adult Western toads were typically seen in talus (rock rubble) slopes, as well as near ponds associated with the larger lakes.

The population of Western toads, like many amphibians, appears to be declining throughout the lowlands of western Washington and the high-elevation wetlands of the North Cascades Complex. Some of these declines are difficult to document (particularly in alpine regions) because of a lack of historical records. Because of these declines, the U.S. Fish and Wildlife Service lists them as a species of concern; the WDFW lists them as a candidate species. Western toad tadpoles are probably not preyed upon by fish because they secrete an unpalatable toxin (Corn 1998).

BULL TROUT (FEDERAL THREATENED, STATE CANDIDATE)

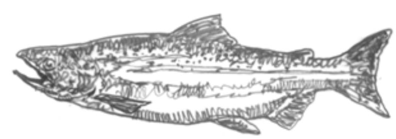
Bull trout (*Salvelinus confluentus*) are a listed species at the federal level and a state candidate species. Dolly Varden (*Salvelinus malma*) are not on the federal or state list, although in 2001 the U.S. Fish and Wildlife Service proposed listing the Dolly Varden as threatened under the "Similarity of Appearance" provisions (66 FR 6: 1628-1632, January 9, 2001). The WDFW refers to bull trout and Dolly Varden char collectively as "native char" because the two species are impossible to reliably distinguish between without genetic analysis. In the study area, Dolly Varden distribution in the Skagit River basin is restricted to Thunder Creek (tributary to Diablo) and tributaries to the upper Skagit River above Ross Lake.

The distribution of bull trout is fairly broad in the west-side drainages of the North Cascades Complex, including Ross Lake, and they were historically documented in the Stehekin River drainage. During extensive surveys, however, none were found (NPS 1999a). It is unclear why bull trout are no longer present in these waters, although the combined effects of over-fishing and successive years of bad weather could be important contributing factors to their disappearance (NPS, S. Zyskowski, pers. comm., 2003). Fluvial (resident in larger streams) and anadromous populations of bull trout currently exist in the Skagit River, while Ross Lake and the Chilliwack River contain lacustrine-adfluvial (lake rearing fish that spawn in streams) populations.

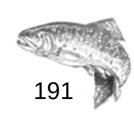
The presence of brook trout in Silver and Hozomeen creeks has generated great concern for potential hybridization (cross breeding) between bull trout and brook trout, although to date, no hybridization has been documented. The current lack of documented hybridization may be related to differences in spawning habitat because brook trout tend to spawn in warmer water, and bull trout spawn in only the coldest water. Though hybridization has not yet been documented, the potential clearly exists (Seattle City Light, E. Conner, pers. comm., 2003).

CHINOOK SALMON (FEDERAL THREATENED)

Chinook (king) salmon are found in the Skagit River and its major tributaries, and smaller numbers are found in the Baker River drainage. Populations of Chinook salmon have been divided into evolutionarily significant units (ESU) for protection under the *Endangered Species Act*. Chinook salmon, currently listed as threatened, is present in the North Cascades Complex, which is part of the Puget Sound ESU. The ecological overlap between Chinook salmon and nonnative trout is questionable, given their vastly different life histories. While hybridization is not known to occur, Chinook salmon fry could be preyed upon or forced to compete with nonnative trout dispersing downstream from mountain lakes. Such competition, however, would take place against the backdrop of the widespread native trout that share similar habitats.



Chinook salmon are found in the Skagit River and its major tributaries.



COHO SALMON (FEDERAL CANDIDATE SPECIES, STATE SENSITIVE SPECIES)

The Georgia Strait / Puget Sound ESU of Coho salmon (*Oncorhynchus kisutch*) is a federal candidate species. Coho are favored by many anglers. Wild stocks of Coho salmon have been greatly reduced throughout California, Oregon, and Washington because of habitat loss, overfishing, hybridization with hatchery stocks, and poor ocean conditions (Behnke 2002). In 1995 these declines prompted the National Marine Fisheries Service to list Coho populations in California and Oregon as threatened. At the same time, however, the National Marine Fisheries Service determined that listing Coho as threatened was not warranted for the Puget Sound / Straight of Georgia ESU, but instead listed that unit as a candidate species.

Coho salmon from the Puget Sound / Straight of Georgia ESU are found in most of the major west-side tributaries of the North Cascades Complex, including the Skagit, Baker, and Chilliwack rivers and their higher-order, lower-gradient tributaries. Less abundant than the sockeye, pink, and chum species, Coho salmon spend their first year in the birth tributary and the next 18 months in the ocean before returning to spawn from November through early February. Since the young spend roughly one year in freshwater before smolting (when young salmon swim to the ocean), they must compete with other native salmonids and, potentially, with introduced fish dispersing downstream. Hybridization has only been documented with hatchery strains of Coho and with their close relative, the Chinook salmon, but not with nonnative rainbow, cutthroat, or char.

WESTSLOPE CUTTHROAT TROUT (FEDERAL SPECIES OF CONCERN)

The westslope (inland) cutthroat trout (*Oncorhynchus clarki lewisi*) is currently listed as a species of concern, but because of continued declines, various conservation organizations have recently petitioned the U.S. Fish and Wildlife Service for a rule to list the westslope cutthroat trout as threatened throughout its range (American Wildlands et al. 1998). Two status reviews of westslope cutthroat trout (in September 1999 and August 2003) concluded that the westslope cutthroat trout is not likely to become a threatened or endangered species within the foreseeable future and that listing was not warranted under the *Endangered Species Act* at this time (*Federal Register* 68 (152):46989-47009).

Westslope cutthroat trout inhabit the Stehekin River and its headwater tributaries. They are the only trout native to the drainage that are still present. The westslope cutthroat trout in the Stehekin River drainage are geographically isolated from other populations of westslope cutthroat trout in the western United States (Behnke 2002).

Stocking of rainbow trout in Lake Chelan, and in various lakes at the headwaters of the Stehekin River, has caused hybridization between westslope cutthroat and rainbow trout. Recent genetic research has demonstrated that rainbow trout dispersing downstream from stocked mountain lakes in the Stehekin River drainage are responsible for some of the hybridization. Rainbow trout stocked in

Lake Chelan and various tributaries to the Stehekin River have also hybridized with westslope cutthroats. This ongoing genetic research has found that two genetically "pure" strains of westslope cutthroat are still present in the headwaters of the Stehekin River drainage and in Park Creek. The persistence of these two pure strains may be related to differences in spawning habitat because westslope cutthroats generally spawn in high-gradient waters, while rainbow trout prefer low-gradient streams in the Stehekin River drainage (WFRC, C. Ostberg, pers. comm., 2003).

OTHER SPECIAL STATUS SPECIES

ANIMALS

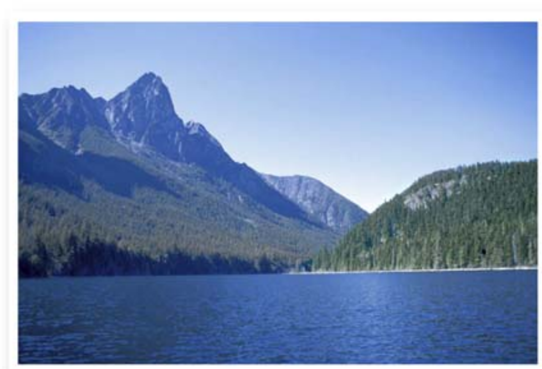
Table 21 lists those species that are recognized as special status species by the state of Washington and are known or likely to occur in the North Cascades Complex but do not have federal status.

TABLE 21: STATE OF WASHINGTON SPECIAL STATUS SPECIES WITH NO FEDERAL STATUS

Common Name	Scientific Name	Species Status
Black-backed woodpecker	*Picoides albolarvatus*	Candidate
Common loon	*Gavia immer*	Sensitive
Golden eagle	*Aquila chrysaetos*	Candidate
Lewis' woodpecker	*Melanerpes lewis*	Candidate
Merlin	*Falco columbarius*	Candidate
Pileated woodpecker	*Dryocopus pileatus*	Candidate
Vaux's swift	*Chaetura vauxi*	Candidate

BLACK-BACKED WOODPECKER (STATE CANDIDATE)

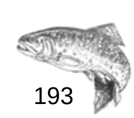
Black-backed woodpeckers inhabit coniferous forests and prefer burned, logged, or swampy areas in the North Cascades Complex. The species nests in tree cavities, usually close to the ground.



Hozomeen Lake is one of only 20 sites throughout Washington State where loon nesting has been confirmed in the last 30 years.

COMMON LOON (STATE SENSITIVE)

Common loons are regular spring and fall migrants and summer post-breeding visitors, with the exception of the pair breeding on Hozomeen Lake. They are rare winter visitors in the North Cascades Complex. Their breeding numbers appear to have declined significantly in Washington State because of the widespread loss of low-elevation lake habitats and associated human disturbance (Richardson et al. 2000). Hozomeen Lake is one of only 20 sites throughout Washington State where loon nesting has been confirmed in the last 30 years. A few loon observations are reported each year from nearly all the major lakes and reservoirs in the North Cascades Complex, but nesting has only been confirmed at Hozomeen Lake where loons have nested



consistently since at least 1971. The area around the lake is closed each season to minimize disturbance. The brook trout food base at Hozomeen Lake, as well as the close proximity to other favorable feeding grounds such as Ross Lake, are probably two key factors in providing favorable habitat. Because of the low numbers of nesting loons in Washington State, common loons are now listed as sensitive in Washington State (Richardson et al. 2000).

GOLDEN EAGLE **(STATE CANDIDATE)**

Golden eagles are large raptors that occupy mountainous areas. Golden eagles prey mainly on small mammals but also hunt other birds. Although golden eagles may be permanent residents of the North Cascades Complex, there are no known golden eagle nests (NPS, R. Zipp, pers. comm., 2003).

LEWIS' WOODPECKER **(STATE CANDIDATE)**

In higher elevations, Lewis' woodpeckers nest in open old-growth ponderosa pine with snags but prefer lower-elevation riparian woodlands dominated by cottonwoods. This woodpecker also prefers logged or burned-out areas. They primarily eat acorns, berries, and insects.

MERLIN **(STATE CANDIDATE)**

Merlins are small, fast falcons that prey on birds and insects. Three subspecies of merlins occur in the North Cascades Complex. The taiga merlin (*Falco columbarius columbarius*) breeds in the high-elevation forests in the North Cascades Complex between April and October (SAS 2002); however, merlins are considered very rare breeders, and the status of nesting in Washington is unknown (WAGAP 2003). Taiga merlins nest in trees near open grasslands, meadows, lakeshores, or forest openings. They may occasionally use the valleys when foraging and during migration (WAGAP 2003).

PILEATED WOODPECKER **(STATE CANDIDATE)**

Pileated woodpeckers are the largest woodpecker species and is a year-round resident of the North Cascades Complex. Pileated woodpeckers inhabit deep, mature forests and use cottonwood trees (*Populus* spp.) along lakes and riparian corridors to prey on carpenter ants.

VAUX'S SWIFT **(STATE CANDIDATE)**

Vaux's swift is an insectivore that nests in tree cavities in mature forests. This bird species migrates south in the winter season. Vaux's Swifts are common in suitable habitat throughout the North Cascades Complex (NPS 1999a).

PLANTS

Appendix C, table C-2, lists the plant species that are recognized as special status species by the state of Washington and are likely to occur in the North Cascades Complex, but do not have federal status. There are 26 graminoid (grass) species, 45 forb (a broad-leaved herbaceous plant that is not a grass) species, and 10 fern species that are state listed. It is not possible to establish the presence or absence of any of these species because surveys for plant species of special concern have not been conducted.

In addition to the state of Washington status, plant species of special concern are classified according to their reliance on wetland (riparian) vegetation assemblages. The U.S. Army Corps of Engineers uses this classification system in wetland delineation. The U.S. Fish and Wildlife Service developed the list of plant species of special concern that occur in wetlands.

Wetlands are classified as follows:

> FAC—facultative (occurring in a variety of conditions) species occur 33% to 67% of the time in wetlands; 9 of the state-listed species are facultative species
>
> FACU—facultative upland species occur 1% to 33% of the time in wetlands; 5 of the state-listed species are facultative upland species
>
> FACW—facultative wetland species occur 67% to 99% of the time in wetlands; 12 of the state-listed species are facultative wetland species
>
> OBL—obligate (only occurring in particular environmental conditions) wetland species occur 99% of the time in wetlands; 18 of the state-listed species are obligate wetland species
>
> UPL—obligate upland species are rarely found in wetlands; 37 of the state-listed species are obligate upland species.

VEGETATION

This section describes vegetative communities in the North Cascades Complex. Species that have special status are described under "Plants" in the previous section titled "Special Status Species."

The terrestrial vegetation of the North Cascades Complex is highly diverse as a result of the co-occurrence of climatic gradients and topographic diversity over relatively short distances. Vegetation and wildlife are influenced by several factors, including climatic differences caused, in large part, by two geological barriers in the North Cascades Complex: the Skagit Crest (Boston-Picket-Spickard Divide) and the Pacific Crest. The west sides of these crests have a temperate marine climate, which is characterized by relatively warm winters and cool summers. Precipitation on the west side ranges from 60 to 138 inches per year. East of these crests, the climate is semiarid continental, with colder winters and hot, dry summers. The east side receives between 25 to 130 inches of precipitation per year (Liss et al. 1995; NPS 2003a). The area between the Skagit Crest and Pacific Crest (the Ross Lake drainage) is a transitional zone where vegetation and climatic characteristics are moderated between the mild, wet conditions typical of the west side and the semiarid conditions typical of the east side of the Cascade Crest.

Elevation influences the type, growth, and distribution of vegetation.

Elevation, and the differences in precipitation and temperature related to it, also influence the distribution of vegetation. In this area, precipitation generally increases with elevation while temperature decreases. Four main vegetation zones are recognized based on differences in elevation and dominant vegetation: lowland forest, high forest, subalpine parkland, and alpine. Climatic differences between the east side and west side influence the distribution of these vegetation zones relative to elevation. Vegetation zones on the east side occur at higher average elevations than their west-side counterparts. This means, for example, that while the alpine zone occupies a significant portion of the west-side watersheds, it is restricted on the east side. East-side forests are drier and have less understory vegetation than west-side forests (Liss et al. 1995; NPS 2003a). While these trends are true for most of the North Cascades Complex, local topography also influences the interaction between vegetation zone and elevation. Therefore, most lakes classified in this document as located in a particular vegetation zone vary consistently with elevation, but sometimes, the influence of local topography means this is not always true. For example, in some cases, a lake classified as high forest may occur at a higher elevation than one classified as subalpine.

Discrete subtypes may occur within these broad vegetation zones. The subtypes are described by the dominant plant stature and result in a cover-type classification. Deciduous and/or coniferous trees are dominant in the forest cover type. The shrub cover type is characterized by the predominance of woody shrubs. Meadow cover describes areas where forbs and graminoids are dominant but may include low-lying shrubs as well. Areas that are not vegetated include exposed bedrock, talus slopes, and cliffs. Descriptions of each cover type are described below and are grouped according to climatic region (the west or east side of the Pacific Crest) and vegetation zone. The descriptions are very general and do not necessarily represent the species actually found at individual lakes. Ground surveys at the lakes are essential in order to characterize the riparian vegetation surrounding individual lakes.

WEST SIDE

The **lowland forest zone** includes 6 of the 91 lakes occurring between 1,350 and 3,380 feet (see “Appendix M: Shoreline Cover Types Around the 91 Study Area Lakes”). Coniferous tree species that dominate the lowland forest cover type are Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western red cedar (*Thuja plicata*). Willows (*Salix* spp.) and vine maple (*Acer circinatum*) are the most common shrub species in this zone. Most lakes in the study area on the west side are surrounded by a combination of the four cover types (forest, shrub, meadow, and bare), although all cover types are not represented at every lake. The forest cover type covers more area in this zone than in higher-elevation zones.

Western Red Cedar

The **high forest zone** includes 10 of the 91 lakes included in this plan/EIS. High forest generally occupies habitat on the west side at elevations ranging between 3,843 and 5,540 feet. The high-forest cover type is dominated by Pacific silver fir (*Abies amabilis*) and mountain hemlock (*Tsuga mertensiana*), with lesser amounts of subalpine fir (*Abies lasiocarpa*), grand fir (*Abies grandis*), and Alaska yellow cedar (*Chamaecyparis nootkatensis*). Douglas fir grows at lower elevations in this zone. Dominant shrub species in this zone are huckleberry (*Vaccinium* spp.) and white rhodedendron (*Rhododendron albiflorum*). As in the lowland forest zone, most lakes are surrounded by a combination of the cover types. The shrub and meadow cover types are more common, and forest cover type is less common than in the lowland forest zone.

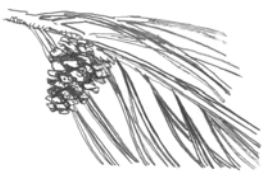
Douglas Fir

The **subalpine zone** includes 49 of the 91 lakes, and occurs on the west side at elevations between 3,685 and 6,560 feet. It is characterized by a mosaic of tree islands and subalpine meadows. The dominant trees in the tree islands are subalpine fir and mountain hemlock, with lesser amounts of whitebark pine (*Pinus albicaulis*). Forest cover is much less common in the subalpine zone than at lower elevations. At the interface between the subalpine and alpine zones, trees are characterized as Krummholtz, a vegetative growth form characterized by clumped, low-stature trees. Heather (*Phyllodoce* spp., *Cassiope* spp.), huckleberry (*Vaccinium* spp.), and willows are dominant shrubs. The heather-huckleberry community is very sensitive to the effects of trampling and takes longer to recover than other plant communities (Cole and Trull 1992). The meadow vegetation in this zone can be grouped into 11 community types ranging from early successional communities on glacial moraines to heather and huckleberry communities. In general, meadow areas are dominated by sedges (*Carex* spp), rushes (*Juncus* spp.), and hellebore (*Veratrum* spp.). The bare cover type is much more common in the subalpine than in the forest zones.

Subalpine Fir

The **alpine zone** includes 6 of the 91 lakes at elevations ranging between 4,055 and 5,830 feet. Alpine plants are low growing and often mat-forming, and alpine plant communities can be sparse or dense. Alpine cover is characterized by fell fields consisting of sedges, grasses, composites, heather, talus, and snowfields. Meadow cover is less common in the alpine zone than in the subalpine zone. The bare cover type predominates in this zone.

EAST SIDE



Ponderosa Pine

The **lowland forest zone** on the east side includes 1 of the 91 study area lakes that occurs at 2,172 feet. Tree species that dominate the forest cover type are Ponderosa pine (Pinus ponderosa), Douglas fir, and lodgepole pine (*Pinus contorta* var. *latifolia*). Lakeshore vegetation is 29% forest cover. Willows are a common shrub species in this zone. The meadow cover type represents more than half of the riparian vegetation at this lake, and there is no area classified as bare cover type.

The **montane forest zone** on the east slope includes 5 of the 91 study area lakes that occur between 5,375 and 5,630 feet. In addition to the silver fir and mountain hemlock, whitebark pine and larch are also common at higher elevations in this zone. Most lakes are surrounded by a combination of cover types.

Western Larch

The east slope **subalpine zone** includes 14 study area lakes that occur between 4,165 and 6,795 feet. This zone has a more moderate level of precipitation than that of the west slope, and the longer growing season allows subalpine vegetation to extend to the ridgetops in most lake basins. Lakeshore tree islands are dominated by subalpine fir, mountain hemlock, larch (*Larix occidentalis*), and whitebark pine (*Pinus albicaulis*). Larch is more common in higher, colder areas than pine, but they are often found together. Heather, willows, and huckleberry are dominant shrubs. Sedges, grasses, rushes, helleborus, and patridgefoot (*Leutkea* spp.) dominate meadow areas. Again, shrubs, meadow, and bare cover types are more common than the forest cover type.

No east-side lakes are classified as alpine.

DECIDUOUS TREES

Throughout the North Cascades Complex, deciduous trees predominate in moist and exposed areas such as floodplains, riparian areas, and avalanche chutes. Common species include bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera* spp. *trichocarpa*), red alder (*Alnus rubra*), vine maple (*Acer circinatum*), and willow (*Salix* spp.).

RIPARIAN VEGETATION

In an ecosystem context, riparian zones are “the interfaces between terrestrial and aquatic ecosystems. As ecotones, they encompass sharp gradients of environmental factors, ecological processes, and plant communities. Riparian zones are not easily delineated but are composed of mosaics of landforms, communities, and environments within the larger landscape" (Gregory et al. 1991). The riparian zone of a lake or pond generally consists of the adjacent land that is periodically influenced by flooding, ponding, or soil saturation. The plants and animals that occupy these zones are often uniquely suited to wetland conditions. In the North Cascades Complex, riparian zones can range from very extensive (for lakes surrounded by wet meadows) to minimal (for lakes surrounded by rock and/or glaciers).

Riparian Vegetation: Vegetation found along waterways and shorelines that is adapted to moist growing conditions and occasional flooding.

Most of the lakes in the North Cascades Complex are oligotrophic, meaning they are low in nutrients and very limited in their capacity to produce and sustain aquatic life. Under these conditions, the ecological role of riparian zones is very important because they provide additional sources of nutrients and carbon to the aquatic food chain. The nutrients from riparian zones greatly augment the lakes' sources of carbon and nutrients that are originally derived from phytoplankton and transferred up the food chain.

Lakes commonly receive nutrients from organic debris such as leaves, pine needles, and fallen branches and trees. While some of this material originates within the immediate riparian zone of the lakes, a substantial amount of debris (especially large, coarse woody debris) can be carried over long distances into lakes by flooding and avalanches. As lake elevation decreases, the growing season lengthens, and the density of riparian zone vegetation increases. These conditions increase the overall lake inputs of nutrients and organic debris from the surrounding basin. This general relationship may help to explain why lake productivity in the North Cascades Complex increases with decreasing elevation.

Riparian zone vegetation in the North Cascades Complex varies widely in relation to elevation. Generally speaking, as elevation increases, forest vegetation gives way to lower shrubs and meadows, and the amount of exposed rock (such as cliffs, bedrock, and talus) along the shoreline increases. Many other factors beside elevation influence the composition and structure of riparian vegetation; those factors include soil, surface geology, aspect, and disturbance history (flooding, avalanches). Many of the lakes in the North Cascades Complex (such as Willow Lake) have wide variations in water level and the corresponding extent of riparian zone vegetation, particularly at lower elevations where a longer growing season favors more rapid growth of vegetation.

Trampling of riparian vegetation has been documented around many lakes in the North Cascades Complex. Except for a few instances (such as horse trampling around McAlester Lake), the impacts cannot be assigned to any particular group because lakeshores are used by many different types of backcountry visitors. In the late 1980s, an observational study of angler use around lakeshores in the North Cascades Complex found that, on average, anglers spent three times longer in riparian zones than other user groups. The researchers hypothesized that if time spent in the riparian zone was proportionate to impacts, then anglers could have up to three times as great an impact as hikers (Hospodarsky and Brown 1992). This hypothesis is based on observations that have yet to be tested in a statistically rigorous study. An unknown, though potentially substantial, number of dedicated anglers use rafts when fishing in mountain lakes, and the use of rafts has the potential to greatly reduce the amount of shoreline trampling (WDFW 2001).

The cover type along shorelines can greatly influence where and how anglers travel around lakeshores. Lakeshores that are dominated by bedrock, talus, and/or snow would be less sensitive to trampling than lakeshores with an abundance of low meadow vegetation that allows for easy walking along the shore. The composition of shoreline vegetation around all lakes with a history of fish stocking is provided in “Appendix M: Shoreline Cover Types Around the 91 Study Area Lakes.”

C U L T U R A L   R E S O U R C E S

Much of the information presented in this “Cultural Resources” section is from the *Final Resource Management Plan* (NPS 1999a) and *An Updated Summary Statement of the Archeology of the North Cascades National Park Service Complex* (NPS 1998). Appendix J contains additional information on documents and plans related to cultural resources within the North Cascades Complex.

The NPS groups cultural resources by these categories: archeological resources, cultural landscapes, historic structures, museum objects, and ethnographic resources. Each category is addressed in the following section, with the exception of museum objects, which would not be affected by the fishery management actions proposed in this plan/EIS.

A R C H E O L O G I C A L   R E S O U R C E S

There is evidence that the general North Cascades area was used extensively by Native American groups for at least the last 8,400 years. It is believed that the earliest inhabitants of the area were ancestors of today's Coast Salish and Interior Salish-speaking people such as the Skagit, Chilliwack, Nooksack, Nlakapamux, Chelan, Entiat, and Methow bands. It is likely that numerous other indigenous bands on both sides of the North Cascades Range would have periodically used the resources of the area.

An archeological overview and assessment (NPS 1986) for prehistoric archeological resources predicted the occurrence of hundreds of cultural resources within North Cascades Complex boundaries. Cumulative results of systematic surveys and site evaluations since that time are compiled in the NPS Archeological Sites Inventory Management System (ASMIS) database. As of 1999, less than 5% of the 684,000 acres in the North Cascades Complex had been formally surveyed for cultural resources.

The NPS has recorded 255 prehistoric archeological sites in the North Cascades Complex. Twenty-three of these sites have been determined eligible for the National Register of Historic Places (National Register). Many other sites have been determined ineligible due to loss of site integrity from reservoir inundation (NPS, R. Mierendorf, pers. comm., 2004).

While most sites are located in river valleys, some are also found in alpine and subalpine locales. In general, the resources reflect extensive use of the North Cascades mountain areas for hunting, gathering, and fishing; food processing and cooking; and working with a variety of other local resources. Site types include lithic scatters (chipped and ground stone); features (living floors, hearths, sweat lodges), stone quarries; collecting areas; hunting, gathering, fishing, and food processing camps; rockshelters, overhangs, and caves; rock features including talus pits, rock walls and alignments, and rock cairns; pictographs; culturally modified trees; permanent and semi-permanent villages and camps; and prehistoric trails and resource use areas. The presence of obsidian (jet-black volcanic glass) from sources in California, Oregon, Idaho, and Wyoming clearly suggests that inhabitants of the area utilized broad and sophisticated regional trade networks.

Approximately 89 historic archeological sites associated with 19th and early 20th century settlement and mining have also been identified in the North Cascades Complex. Twenty-nine of these sites have been determined eligible for the National Register (NPS, J. Kennedy, pers. comm., 2004).

For the purposes of evaluating impacts to cultural resources, 6 trails and 8 of the 91 lakes considered in this plan/EIS have been designated sensitive because of an increased potential for impacts to archeological resources from proposed fishery management actions (NPS, R. Mierendorf, pers. comm., 2004). Information regarding these sensitive archeological resources is contained in a confidential document that is not available for public release.

HISTORIC STRUCTURES AND DISTRICTS

Historic development in the North Cascades occurred relatively late, primarily within the last 200 years, partly due to the rugged landscape and relative isolation of the area. Historic contexts identified in a 1986 historic resource study (Luxenberg 1986) include exploration primarily in the Skagit, Cascade, and Stehekin river valleys; followed by settlement, commercial development (including miners), recreation, and administration of the area by the U.S. Forest Service. Forty-three buildings, five sites, and one structure were found to be eligible for inclusion in the National Register as a part of the multiple resource nomination (Luxenberg 1989).

Numerous additional historic resources have been identified in the North Cascades Complex and include cultural landscapes, districts, and structures. These historic resources primarily represent pioneer homesteads; placer, hydraulic, and hard rock mines; wagon roads and trails (for example, mine-to market wagon roads); recreation; and federal land management. Twenty-nine historic structures are listed in the National Register.

Four generators went on-line when Ross Dam was completed in 1952.

The Cascade Pass trail corridor contains several historic roads and trails that likely date back to the late 19th century and form an east-to-west passageway through the North Cascades mountains. One lake has been identified as particularly sensitive to human activity because of several historic sites located in the immediate vicinity (NPS, J. Kennedy, pers. comm., 2004).

Perhaps the most notable evidence of historic human use of the area is reflected in the facilities associated with the Skagit River Hydroelectric Project and associated reservoirs operating in the North Cascades Complex. The 540-foot-high Ross Dam, which created the 11,680-acre Ross Lake, was completed in 1949. Diablo Dam was completed in 1927 and is 389 feet tall; Diablo Lake covers 910 acres. Gorge Dam, completed in 1961, is 300 feet tall and its reservoir (Gorge Lake) inundates 210 acres. Together, the dams, power houses, and related facilities comprise the Skagit River Hydroelectric Project No. 553, an inholding in the North Cascades Complex that is owned and managed by Seattle City Light. Many features of the Skagit River Hydroelectric Project are either eligible for or listed in the National Register, including the company towns of Newhalem and Diablo.

Ethnographic Resources

Ethnographic resources represent tangible evidence of the past and present behavior or knowledge of identifiable human populations in a geographic area. They are often intimately related to other categories of both natural and cultural resources. Such data create an ethnographic baseline for interpreting connections between archeological data and native inhabitants. The ethnographic resource types that have been identified for further study in the North Cascades Complex include historic and contemporary human populations, historic and contemporary subsistence uses and residency, current uses of ceremonial or religious localities by indigenous people, traditional sacred localities and/or objects, ethnogeographic resources, and Traditional Cultural Properties (see National Register Bulletin 38, http://www.cr.nps.gov/publications/bulletins/nrb38/). No ethnographic resources have been documented in the North Cascades Complex, although it is very possible that some do exist (NPS, R. Mierendorf, pers. comm., 2004).

Cultural Landscapes

Within the past decade, cultural landscapes have come to formally represent a distinct cultural resource group, reflecting human adaptation to using the natural resources in a given area. Efforts to document and understand the natural and cultural resources of the landscape in the North Cascades Complex were completed in the past, but additional work is believed necessary. The North Cascades Complex contains a diversity of cultural landscape resources including backcountry homesteads, 19th century resort developments, historic administrative areas, and trails. In 1998, as part of a cultural landscapes inventory, 24 individual sites and districts were identified in the North Cascades Complex as cultural landscapes. While most have not been evaluated, several have been determined eligible by the Keeper of the National Register or the Washington State Historic Preservation Office. These cultural landscapes include the International Boundary Corridor, Golden West Lodge, Horseshoe Basin and Black Warrior Mine, Buckner Homestead, and Marblemount Ranger Station.

Sourdough Lookout was constructed in 1932 and is in the National Register of Historic Places.

VISITOR USE AND EXPERIENCE

Visitation to the North Cascades Complex from 1996 to 2002 fluctuated slightly but generally remained at an average of 412,012 people per year (see table 22).

Approximately 449,216 people visited the North Cascades Complex in 2002. The national park portion of the North Cascades Complex received approximately 5% of total visitation, with the highest use in the area around Cascade Pass. The Lake Chelan National Recreation Area experienced 9% of total use, and Ross Lake National Recreation Area experienced 86% of total use. The highest use occurred in July and August and the lowest in January and February. Approximately 80% of the visitors to Ross Lake National Recreation Area (310,700 people) traveled along State Route 20. The wilderness character of the North Cascades Complex accounts to some degree for the relatively low backcountry overnight use. Of the estimated 449,216 visitors in 2002, only 37,231 visitors (this figure includes all backcountry areas including the areas around the reservoirs) spent one or more nights in the backcountry (NPS 2003c).

Visitation increased from 1996 to 1998, then decreased the following two years. Visitation began increasing again in 2001.

TYPES OF RECREATIONAL OPPORTUNITIES IN THE NORTH CASCADES COMPLEX

The majority of visitors (86% in 2002) to the North Cascades Complex recreate in Ross Lake National Recreation Area along State Route 20 and do not venture far from the highway corridor. Recreational opportunities available along the highway corridor include bicycling, day hiking, picnicking, and fishing. Several

TABLE 22: TOTAL VISITATION TO THE NORTH CASCADES COMPLEX, 1996 TO 2002*

	Location				
Year	North Cascades National Park	Ross Lake National Recreation Area	Lake Chelan National Recreation Area	Total (all areas)	Percent Change
1996	27,910	313,565	36,891	378,366	
1997	27,203	332,164	34,300	393,667	4%
1998	32,753	425,209	45,779	503,741	28%
1999	21,488	333,944	50,087	405,519	-19.5%
2000	25,704	273,696	51,825	351,225	-13.4%
2001	27,739	332,061	42,547	402,347	14.6%
2002	20,690	387,936	40,590	449,216	11.6%
Average	26,212	342,654	43,146	412,012	4.2%
North Cascades Complex Average Annual Visitation (1996–2002)				412,012	

Note:

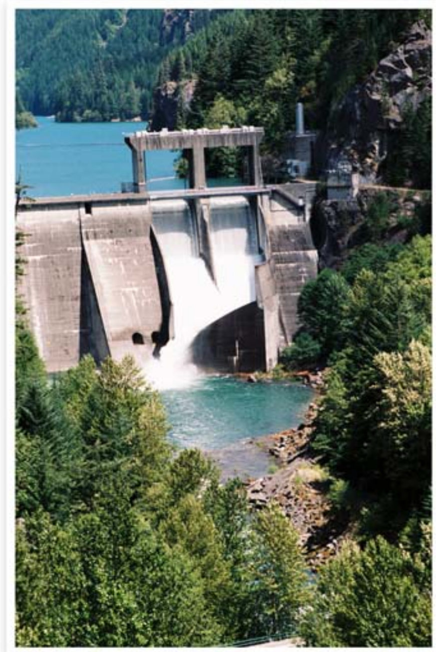
*Visitation information was obtained from http://www2.nature.nps.gov/stats/ (NPS 2003c).

rest stops provide interpretive displays and scenic vistas. Seattle City Light offers tours of the Skagit River Hydroelectric Project, which is popular during the summer months.

Although use is comparatively lower, the backcountry of the North Cascades Complex also offers a wide variety of recreational opportunities, including boating, paddling, hunting (in the recreation areas only), hiking, camping, rock climbing and mountaineering, horseback riding, and sport fishing in mountain lakes, creeks, rivers, and reservoirs. Approximately 8% of visitors in 2002 spent one or more nights in the backcountry.

Boating typically occurs in the reservoirs in the North Cascades Complex. Paddling, such as kayaking or canoeing, occurs on the larger rivers, particularly the Stehekin and Skagit rivers. No boating or paddling occurs in the mountain lakes. Very few people hunt, and hunting is limited to the national recreation areas. Hunting season typically occurs in the fall and winter when mountain lakes ice over and visitation is low.

The following sections describe the recreational opportunities available in the North Cascades Complex.



Since 1918, Seattle City Light has operated the Skagit River Hydroelectric Project to deliver power to the city of Seattle. Gorge Dam (shown above) was completed in 1924.

Hiking and Backcountry Camping

Hiking is one of the most popular backcountry activities in the North Cascades Complex, which contains 386 miles of maintained trails that provide a wide range of experiences, including long hikes through deep forested valleys and steep climbs to breathtaking alpine scenery. Lower-elevation trails are usually accessible from early April through mid-October. Higher-elevation trails (which comprise most of the backcountry in the North Cascades Complex) do not open until mid-July and remain accessible through late September.

The backcountry trail network extends beyond the North Cascades Complex boundary onto National Forest System lands and wilderness areas. The Pacific Crest Trail, a designated National Scenic Trail that extends from the California/Mexico border to the Washington/Canada border, passes through the South Unit of North Cascades National Park and Lake Chelan National Recreation Area. This is a popular, well-established trail used by through-hikers and people wanting to access Stehekin Valley from State Route 20. Hikers on the trail tend to congregate in the community of Stehekin for supplies, showers, and mail, but they must take a shuttle van (or hike) from High Bridge to Stehekin. Various other users, such as day hikers and overnight hikers, use portions of the trail without necessarily congregating in any one place, other than perhaps the road/bridge crossing at High Bridge and along State Route 20 outside the park at Rainy Pass.

The 60-mile portion of the Pacific Northwest Trail, which passes through the North Unit of North Cascades National Park and Ross Lake National Recreation Area, is a designated National Recreation Trail. The Pacific Northwest Trail stretches from Glacier National Park in Montana to Cape Alava on the Pacific Ocean in Olympic National Park. The portion of the Pacific Northwest Trail in the North Cascades Complex enters the east side of Ross Lake National

Camping at Perfect Pass.

Recreation Area along the Devils Dome Loop, skirts Ross Lake via the East Bank Trail, travels northwest along the Big Beaver Trail into the Little Beaver drainage, and continues west over Whatcom and Hannegan passes. The trail is evolving, and a small section adjacent to State Route 20 in Ross Lake National Recreational Area is currently under construction, so it does not yet completely traverse the park (see "Map 2" located in the envelope that accompanied this plan/EIS).

Camping is permitted only at designated backcountry campsites or in untrailed cross-country zones. The most commonly used backcountry sites occur along the shores of Ross Lake. These sites accommodate between 25% to 40% of total backcountry overnight users, excluding those who camp in cross-country zones. The North Cascades Complex has over 200 backcountry campsites that are formally maintained by the NPS. The "Map 2 Table" (in the envelope that accompanied this plan/EIS) lists the 91 study area lakes and the cross-country zones and established camps near those lakes.

Cross-country zones are a wilderness area classification used to manage backcountry overnight use in the untrailed portions of wilderness in the North Cascades Complex. There are two types of cross-country zones: Zone I areas include popular climbing routes and bivouac (temporary camp) sites; Zone II areas represent approximately 90% of the wilderness and are considered the most pristine, with little evidence of human presence (NPS 1989). In cross-country zones, dispersed camping is permitted, and camping next to lakes (both with and without fish) is common. The party size in cross-country zones is limited to 12 in Zone I and 6 in Zone II, and campfires are prohibited in all areas of cross-county zones.

CLIMBING AND MOUNTAINEERING

Mountaineering in the North Cascades Complex is becoming more popular.

The North Cascades Complex is a renowned destination for mountaineering. All levels of difficulty are available, from easy ascents to arduous, multi-day approaches and climbs that challenge even the most skilled mountaineer. Anecdotal evidence suggests that some backcountry climbers carry a fishing rod and fish in mountain lakes, although no data is currently available to determine what percentage of climbers fish in this opportunistic fashion. Eldorado Peak is accessed via the Cascade River Road that reaches its highest point near Cascade Pass. Forbidden Peak and Boston Peak are the most popular for mountaineering because they are the easiest to access and a moderate level of difficulty.

In addition to mountaineering, various newer forms of climbing, including bolted sport climbing and bouldering, are becoming increasingly popular in the frontcountry portions of Ross Lake National Recreation Area. The sudden increase in these nontraditional types of climbing has prompted the NPS to place a voluntary moratorium on new route development. An environmental assessment is planned for the winter of 2004 to address the impacts of climbing and to develop a climbing management plan.

Stock Use and Horseback Riding

Many trails and backcountry camps are available for stock use, which is limited to horses, mules, and llamas. Twenty-nine backcountry camps are available for stock use in the entire North Cascades Complex. Horseback riding is especially popular on the eastern side of Lake Chelan National Recreation Area in the Stehekin River valley. Concessioners in Stehekin lead horse tours into the North Cascades Complex, and some of the horse tours include fishing. Of the 91 lakes in the study area, 11 (see table 23) are accessible by horseback (the number of stock [horses, mules, llamas] users that fish in mountain lakes is not known). Seven of the 10 lakes provide good fishing opportunities and 7 are stocked (none are fishless). Six lakes (Coon, Hozomeen, McAlester, Rainbow Upper West and South, and Willow) are stocked by aircraft (refer to table 11 in the "Alternatives" chapter for methods used to transport fry to lakes that are currently stocked). Coon and McAlester lakes are located in the Lake Chelan National Recreation Area near the concessioners.

Fishing

Archeological records indicate that humans have been fishing in the lower-elevation creeks, rivers, and lakes around the North Cascades Mountains for at least 8,000 years; however, the purpose of fishing has changed from subsistence to sport. The locations of sport fishing have also expanded to include historically fishless mountain lakes.

Table 23: Lakes Accessible by Horseback

Lake Name	Stocked	Fishing Potential
Coon	Yes	Good
Dagger	No	Good
Dee Dee, Upper	Yes	Good
Hozomeen	No	Good
McAlester	No	Good
Rainbow, Upper (West)	Yes	Poor
Rainbow, Upper (South)	Yes	Poor
Ridley	Yes	Good
Unnamed MR-11-01	Yes	Fair
Willow	Yes	Good

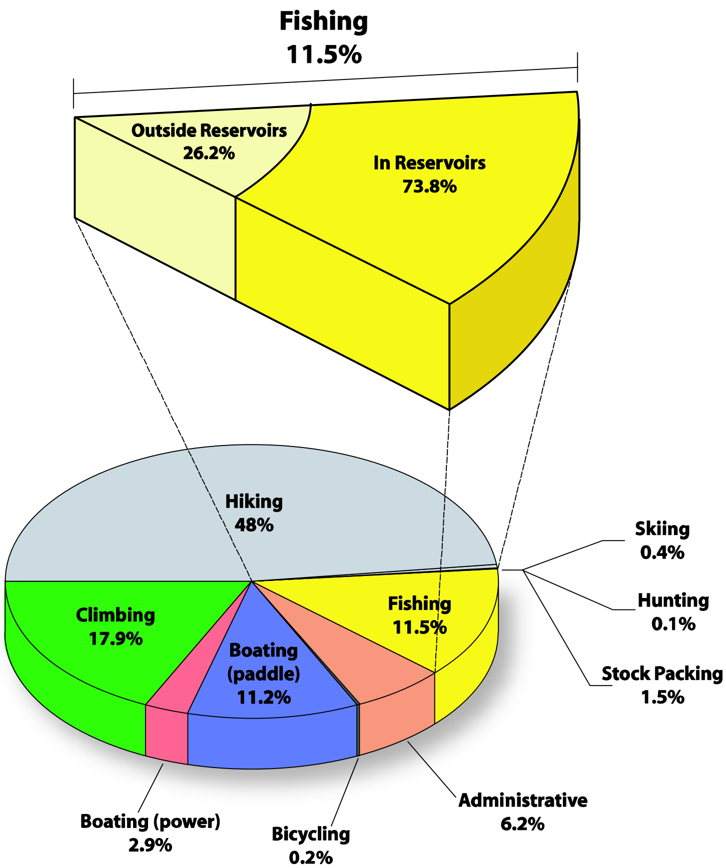
The state of Washington estimates that there are nearly 4,700 high lakes east and west of the Cascades (WDFW 2001). High lakes are defined as greater than 2,500 feet in elevation on the west side of the Cascades, and greater than 3,500 feet on the east side of the Cascades. Of these, 800 are reported to be stocked and 1,000 have reproducing fish populations. Within a 100-mile radius of the North Cascades Complex's boundaries (in Whatcom, Skagit, and northern Snohomish counties), approximately 200 lakes are stocked by the state, and another 200 are estimated to have reproducing fish populations. While the number of anglers using these lakes is unknown, there is opportunity for sport fishing in the vicinity of the North Cascades Complex.

Generations of anglers have fished the mountain lakes in the North Cascades Complex.

Estimates of current angler use were derived from several sources. A survey in 1995 of resident game fish anglers in Washington State found that roughly 175,000 people fished in Washington lakes (WDFW 1996). The mountain lakes in the North Cascades Complex account for roughly 3% of the total number of lakes in Washington, so a general estimate of mountain lake angler use in the North Cascades Complex would be roughly 5,250 people each year. This estimate is likely too high because it does not account for various limiting factors such as access difficulties, distance to large population centers, and differences in use among the various land management agencies that provide mountain lake fishing opportunities outside the North Cascades Complex.

Within the North Cascades Complex, the reservoirs, rivers, streams, ponds, and mountain lakes provide a variety of opportunities to fish in a spectacular mountain setting. Approximately 74% of anglers fish the reservoirs (see figure 9 and table 24), which indicates the reservoirs are the most popular areas to fish. Ross Lake Reservoir is the most popular sport fishing destination on the west side of the park. On the east side of the North Cascades Complex, Lake Chelan and its parent tributary, the Stehekin River, are the most popular fishing locations. Fishing in the natural mountain lakes is largely limited to the summer months when the lakes are ice free, but some of the lower-elevation lakes (such as Willow and Coon) can be fished in the shoulder seasons when the higher-elevation lakes are still ice covered. The running waters of the North Cascades Complex are difficult to fish during spring and early summer because of high flows created by snowmelt.

FIGURE 9: 2003 VISITOR BACKCOUNTY OVERNIGHT USE ACTIVITIES



Note:

The percentages shown in the chart are derived from table 24, which shows the number of nights spent (per person) at permitted backcountry overnight use locations by intended activity during the 2003 summer season.

TABLE 24: RELATIVE POPULARITY OF VARIOUS ACTIVITIES IN THE NORTH CASCADES COMPLEX

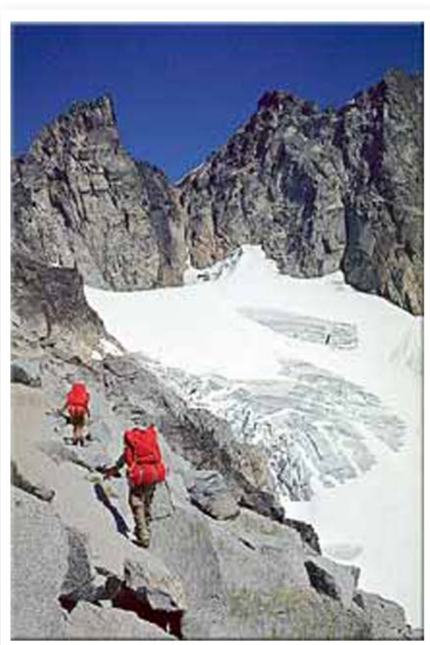
Activity	Percent of Total Use[a]	Percent of Total Use Near Mountain Lakes[b]
Administrative use	6.2	11.1
Bicycling	0.2	NA[c]
Boating (paddle)	11.2	2.1
Boating (power)	2.9	NA
Fishing	11.5	10.5
Hiking	48.0	65.1
Hunting	0.1	0.2
Rock climbing and mountaineering	17.9	8.2
Skiing	0.4	0.5
Stock Packing	1.5	1.6

Notes:

a. This "Percent of Total Use" shows the relative percentage or popularity of various activities throughout the North Cascades Complex.

b. The "Percent of Total Use Near Mountain Lakes" column excludes data from the reservoirs and other areas in the North Cascades Complex that do not provide mountain lake fishing. These areas include backcountry camps near the 91 study area lakes and cross-country zones that may contain any of the study area lakes. The data are derived from the backcountry permit database for the summer 2003 field season (NPS 2003c).

c. NA = not applicable.



The North Cascades are a renowned destination for mountaineering.

Backcountry Overnight Use

Data from the 2003 season show that 11.5% of all backcountry overnight users were engaged in fishing (refer to figure 9 and table 24) throughout the North Cascades Complex, not just in the study area lakes. The backcounty permit data account for backcountry overnight use in established camps and cross-country zones of various shapes and sizes. A cross-country zone could have a lake or a group of lakes that may be fishable, but the lake(s) could also be visited by hikers or completely bypassed by climbers headed to a popular peak in the same cross-country zone. Recognizing the limitations of this information, analysis of backcountry data from the 1999–2002 seasons indicates that the average annual backcountry overnight use for all camps and cross-country zones near the 91 study area lakes was approximately 4,035 people per season (see "Map 2" and "Map 2 Table" located in the envelope that accompanied this plan/EIS).

Prior to the 2003 summer season, the backcountry permit data could only provide total estimates of backcountry overnight use by all visitors; no data were available to indicate what fraction of visitors were engaged in sport fishing. To improve the backcountry permit data and enhance understanding of the popularity of various backcountry activities, including sport fishing, beginning in 2003 all backcountry overnight users were asked to identify their primary activity when they were issued a permit to camp. Analysis of those data for the 2003 season (NPS 2003c) indicates that approximately 10.5% of all overnight visitors to camps and cross-country zones near the 91 study area lakes (that is, those areas that provide mountain lake sport fishing opportunities) intended to sport fish (refer to table 24). Using the estimated average annual backcountry overnight use amount of 4,035 people per season (as shown in the previous paragraph), it was estimated that 424 of the backcountry overnight users engaged in sport fishing (4,035 × 10.5% = 424).

Day Use

For most visitors, only a few lakes in North Cascades Complex can be reasonably fished in one day without camping. These eight day-use lakes include Hozomeen, Willow, Ridley, Monogram, Lower and Middle Thornton, Hidden, and Coon (Thunder Lake is also a day-use lake but is currently fishless). It should be noted that a small number of experienced anglers fish in other lakes in the North Cascades Complex without camping overnight.

In the summer of 2003, NPS personnel and researchers from the University of Washington conducted visitor use surveys at the most accessible day-use lakes, except Thunder Lake. The surveys (approved by the Office of Management and Budget—approval number 1024-0224) were conducted on randomly selected weekdays and weekends from July 12, 2003, through August 31, 2003. To conduct the surveys, NPS personnel were stationed at trailheads and surveyed day users as they were leaving the lakes. A total of 444 people were surveyed.

Preliminary analyses from those visitor-use surveys suggest that a very small percentage (less than 3%) of day users surveyed were fishing, excluding Coon Lake, which experiences substantially higher fishing visitation (see table 25). The survey data also indicate that, while day-use fishing is possible at Monogram Lake, no anglers were fishing there, and none were surveyed during the survey period. The 5-mile one-way hike to Monogram Lake is very steep (approximately 5,000 feet of elevation gain), and its arduous access may limit angling to mostly overnight users. The percentage of day users engaged in fishing at Coon Lake was higher (approximately 20%), perhaps because the lake is an easy 15-minute walk from the Stehekin Valley Road and is also relatively close to the community of Stehekin. In summary, the day-use angler surveys indicate that approximately 75 day-use anglers fished during the survey period from July 12, 2003, through August 31, 2003 (see table 25).

TABLE 25: DAY-USE ANGLING STATISTICS

	Hozomeen, Willow, and Ridley Lakes	Lower and Middle Thornton Lakes	Monogram Lake	Coon Lake	Hidden Lake
Estimated total day use is 1,432 people[a]	244	409	113	239	427
Percent of day users engaged in fishing[b]	2.9	2.4	0	20	2.3
Estimated total for day-use anglers is 75	7	10	0	48	10

Notes:

a. Day-use visitors were surveyed on randomly selected weekdays and weekends during the survey period from July 12, 2003, through August 31, 2003. Data from those surveys were extrapolated for the entire survey period to calculate estimates of total day use.

b. The percent of day users engaged in fishing represents the actual percentage of surveyed day users who said they were fishing; those data were also used to estimate the total number of anglers who fished during the survey period.

Angler Use Summary

In summary, deriving an estimate of total angler use of mountain lakes in the North Cascades Complex is very challenging because of the following factors:

Angler use is small and dispersed across an extremely large area.

An unknown, but potentially significant, number of backcountry overnight users do not acquire backcountry permits.

Many backcountry anglers are seeking a remote wilderness experience and purposefully avoid contact.

There is high variability in arrival and departure times and entry/exit points.

In light of these limitations, the preliminary NPS estimates on sport fishing in the mountain lakes is approximately 499 anglers per year; of that amount, 424 (85%) were backcountry overnight anglers, and 75 (15%) were day-use anglers. These estimates are likely very conservative. A more reasonable estimate of annual angling use of the 91 study area lakes would be about 1,000 people per year, when taking into account incomplete sampling due to dispersed access, highly variable and broad times of entry and departure, and purposeful or inadvertent avoidance of backcountry permit registration.

SOCIAL VALUES

Two predominant issues surround the management of the fishery in the North Cascades Complex mountain lakes. First, the long-held tradition of sport fishing by generations of anglers and their families is predominant among the angler user groups. Second, the conservation of natural processes in the North Cascades Complex is of concern to conservationists and conservation groups, as well as many anglers, especially because the majority of the North Cascades Complex is protected as designated wilderness.

ATTITUDES TOWARD WILDLIFE

Extensive literature exists concerning general social attitudes and values towards wildlife, although no systematic surveys of information specific to the stocking of nonnative fish in the North Cascades Complex exist. For example, Kellert (1976) identified a number of distinct attitudes toward wildlife including aesthetic, dominionistic, ecologistic, humanistic, moralistic, naturalistic, negativistic, scientistic, and utilitarian (see table 26 for definitions).

Most people typically hold more than one attitude toward an issue and react differently in different situations. Nonetheless, it is possible to identify in most people predominant characteristics of a primary attitude toward an issue. For example, ranchers tend to have a utilitarian (value measured in terms of usefulness) attitude towards animals, while scientists tend to take a scientific view (Kellert 1976).

TABLE 26: PEOPLE'S PERCEPTIONS OF ANIMALS IN AMERICAN SOCIETY

Attitude	Key Identifying Terms	Highly Correlated With	Most Antagonistic Toward
Aesthetic	Artistic character and display	Naturalistic	Negativistic
Dominionistic	Mastery, superiority	Utilitarian, negativistic	Moralistic
Ecologistic	Ecosystem, species interdependence	Naturalistic, scientistic	Negativistic
Humanistic	Pets, love for animals	Moralistic	Negativistic
Moralistic	Ethical concern for animal welfare	Humanistic	Utilitarian, dominionistic, scientistic, aesthetic, negativistic
Naturalistic	Wildlife exposure, contact with nature	Ecologistic, humanistic	Negativistic
Negativistic	Avoidance, dislike, indifference, fear	Dominionistic, utilitarian	Moralistic, humanistic, naturalistic
Scientistic	Curiosity, study, knowledge	Ecologistic	None
Utilitarian	Practicality, usefulness	Dominionistic	Moralistic

Source: S. Kellert (1976).

Settlers began stocking North Cascades lakes in the late 1800s with exotic (nonnative) fish (*Oncorhynchus* and *Salvelinus* spp.), and these stocking activities were most likely for subsistence or utilitarian purposes, rather than pure sport. By the 20th century, stocking was a routine management practice for the U.S. Forest Service and various counties to promote sport fishing—a form of recreation.

A shift in values from a purely utilitarian view of the mountain lakes to more scientific and aesthetic views evolved further when in 1933, the Washington Department of Game (currently the Washington Department of Fish and Wildlife) assumed responsibility for stocking mountain lakes throughout the state in order to establish and maintain a recreational fishery. The department's involvement grew largely out of the need to prevent haphazard stocking by individuals without biological expertise. With particular emphasis on systematic assessment of fish species and stocking rates, the department conducted the first lakes fishery research and developed many principles central to fishery management today.

Throughout the 1980s, the NPS and WDFW entered into a series of agreements concerning the management of the fishery (see the "Purpose of and Need for Action" chapter for further information). Attitudes evolved further into more ecological and naturalistic-based values as NPS policies prohibited the introduction of exotic (nonnative) species into areas under its jurisdiction. In order to further define the scientific effects of fish stocking, the NPS initiated a long-term research effort with Oregon State University to evaluate effects of fish stocking on native biota in mountain lakes.

While overall public policy evolved, the concerns of groups representing a variety of attitudes and values also evolved. In 1991 the North Cascades Conservation Council (NCCC) challenged the NPS on a number of issues that brought about a Consent Decree (see appendix A) between the two parties. In part, the Consent Decree ordered the NPS to "conduct a NEPA [*National Environmental Policy Act*] review of the fish stocking of naturally fish-free lakes within [the park] upon completion of ongoing research." This, and the designation of wilderness within the North Cascades Complex, has intensified the debate between the individuals and groups holding various attitudes toward continuation of stocking and conservation of natural processes. These values are further described in the following section.

SOCIAL VALUES OF ANGLERS AND ANGLER USER GROUPS

Sport fishing in the North Cascades Complex follows a tradition that precedes the designation of the North Cascades Complex as a unit of the NPS by almost a century. The traditions and social values surrounding the mountain lake fishery are clearly embodied in two Seattle-based sport clubs: the Washington State Hi-Lakers and Trail Blazers, Inc. The Hi-Lakers are "a diverse group of engineers and schoolteachers, lawyers and contractors, University of Washington professors and research scientists, artists, consultants, and free-lance writers united by a shared passion for mountain lakes" (Bain 2003). Some of the members of the Hi-Lakers are also affiliated with the Trail Blazers. The current membership of the Trail Blazers and Hi-Lakers is approximately 60 people. Membership in these groups appears to be holding steady, with new members joining at the rate of 1 to 5 people a year, offsetting attrition. These numbers, however, are a poor correlation of overall angling use because many anglers do not belong to formal clubs such as these.

Middle Thornton Lake being stocked by a Trail Blazer.

Founded in 1933, the Trail Blazers have voluntarily assisted the WDFW with mountain lakes fishery management, including taking eggs, providing funding for maintenance and equipment, carrying and stocking fry in lakes, and collecting fish observation data. The Trail Blazers have also created and maintained an extensive high [mountain] lake and stream database that includes data on lake and stream identity, location and physical characteristics, fish stocking, fish observations, water chemistry, water biology, and recreational use. In this unique capacity, the Trail Blazers have assumed a role for 70 years as a *de facto* right arm for the WDFW's mountain lakes fishery management program (WDFW 2001).

Although the Trail Blazers and Hi-Lakers represent perhaps the most well-known user groups associated with mountain lakes sport fishing, other mountain lake anglers are also passionate about fishing in mountain lakes but do not belong to a formal group.

The passion for mountain lakes fishing that is shared by the Trail Blazers and Hi-Lakers reflects a set of values and traditions that have been passed down through several generations. Although members of the Trail Blazers and Hi-Lakers enjoy fishing in mountain lakes throughout the state, the rugged, remote, and highly scenic qualities of the mountain lakes in the North Cascades Complex offer an unparalleled backcountry fishing experience that cannot be duplicated elsewhere (Hi-Lakers and Trail Blazers, S. McKean, pers. comm., 2003).

Few studies of the sociological dimensions of sport fishing in North Cascades Complex lakes have been conducted, so an understanding of the social values surrounding sport fishing is limited to secondary data from related studies in similar areas. Results from a study of alpine lake fishing in the Alpine Lakes Wilderness Area in Washington State (Hendee et al. 1977) reveal some useful parallels for understanding the social values surrounding fishing in the North Cascades Range. This study found that sport fishing helped to facilitate natural appreciation and social contact between members of a party and, to a lesser extent, between parties. Indeed, for many anglers the social dimensions of fishing were often more important than successfully catching fish, and this may help to explain why fishermen spent an average of only two hours per day actually fishing. When anglers were asked to rank and prioritize their reasons for visiting lakes, fishing was found to be *secondary* to nature and scenery appreciation, as well as companionship. Other primary motives given for visiting mountain lakes include relaxation, escaping daily routine, hiking, and photography. Taken together, these results suggest that sport fishing is but one of many activities associated with the total outdoor experience.

Some representative opinions expressed during public scoping (conducted in 2003) include:

> Sportsmen, including anglers, were instrumental in getting the . . . park . . . established by Congress in the 1960s . . . it was the intent of the legislation to continue fish stocking in the high lakes of the . . . park
>
> I think that all avenues should be explored in keeping the program running. Catch and release, fly fishing only . . . heartier species, all should be examined to keep what is an outstanding recreational sport going.
>
> . . . to catch a native trout in a pristine lake high up in the mountains with no one else around except a friend, son or daughter and to share this experience with them is one of the greatest highlights of my life.

Social Values of Conservation Groups

In contrast to the value placed upon the mountain lake fishery by groups such as the Trail Blazers and Hi-Lakers, many other groups and individuals believe that the mountain lake fishery in the North Cascades Complex violates the spirit and intent of the *Wilderness Act* and NPS conservation mission. While many anglers are also conservationists, there is a distinction between those who value the stocking of lakes for their enjoyment, in contrast to those who value the conservation and protection of natural processes. Many of the conservation values are intertwined with the value of wilderness. Because the *Wilderness Act* speaks directly to specific wilderness values, that topic is addressed separately.

The establishment of the North Cascades Complex in the late 1960s coincided with the need of the American public to protect natural areas and regulate the protection of air, water, and other environmental resources. During this period, the NPS also responded to critics who maintained that parks were being managed for their scenic and visitor use values and were not being managed in accordance with ecological principles. Hence, based upon recommendations of the Advisory Board on Wildlife Management in National Parks that were authored by the son of Aldo Leopold, NPS policies shifted to scientific research to understand and promote natural processes (Louter 2003).

In 1975 the North Cascades Complex instituted a new fishery management policy. Up until that time, the NPS allowed stocking, but in 1975 the new policy stated it would no longer stock naturally fish-free lakes but would allow for naturally reproducing populations of fish to exist in lakes that could support this "natural" process. This represented a shift, and compromise, between those holding more ecologically based views and the anglers who had a tradition of sport fishing in the mountain lakes (Louter 2003).

Depending on the park leadership at any one time, a series of policy shifts continued for the next 20 years. These policy shifts resulted in agreements with the state of Washington, as well as a commitment to conduct scientifically based research to help determine the long-term impacts of fish stocking.

The 1991 Consent Decree between the NPS and North Cascades Conservation Council directed the NPS, among other things, to develop a fishery management plan based upon results of scientific study. While the North Cascades Conservation Council is not the only conservation-based group involved in the protection of the North Cascades Complex, it most likely represents the view of others sharing ecologically based values.

During the public scoping period for this plan/EIS, conservationists expressed the following opinion of continued stocking:

> There is no stated objective to establish Park aquatic ecosystems as scientific reference areas and to use them in comparison of other non-park Wilderness area fishery management or other management in aquatic ecosystems of the Cascades. The mere fact that there are literally thousands of Cascade lakes outside of NPS areas should be recognized as part of the analysis. NPS is not constrained to provide fishing opportunities that exist elsewhere.
>
> What are the impacts of planting nonnative fish raised in a controlled environment and with antibiotics into the most pristine environments remaining in the United States?
>
> We are concerned that introducing fish into an environment in which they do not exist naturally . . . leads to impacts to amphibian species and their offspring which become food source for the fish.

The contending social values of preservation and recreation represent in many ways the core of the fishery management controversy in North Cascades (Louter 2003).

WILDERNESS VALUES

The *Wilderness Act*, passed on September 3, 1964, "provides a degree of protection to the resources of the National Park System that the NPS *Organic Act* does not." The House Report accompanying the act, which helps to clarify congressional intent with respect to the act, states that its purpose is to establish a National Wilderness Preservation System made up of designated wilderness areas "because of the undeveloped character of their lands and the need to protect and manage them in order to preserve, as far as possible, the natural conditions that now prevail" (House Report No. 1538, 88th Congress, 2nd session, July 2, 1964).

A basic principle of the *Wilderness Act* is that "uses not incompatible with wilderness preservation should be permitted in areas included within the National Wilderness Preservation System." Another basic principle is that "currently authorized uses that are incompatible with wilderness preservation should be phased out over a reasonable period of time." The House Report contains a "compatible uses" subsection, which states that hunting and fishing are permitted "to the extent not incompatible with wilderness preservation" (House Report No. 1538, 88th Congress, 2nd session, July 2, 1964).

The *Washington Parks Wilderness Act of 1988* designated over 630,000 acres in the North Cascades Complex (North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area) as wilderness. The North Cascades Complex contains close to 400 miles of trails throughout the 93% of the land area that is designated as the Stephen T. Mather Wilderness. The designation of this wilderness did not speak to the appropriateness of fish stocking. NPS policies generally reflect that natural processes should prevail in wilderness areas and recognize that without natural resources, especially native species, a wilderness experience would not be possible. Policies also apply the principle of nondegradation, where natural processes will be allowed as much as possible to support wilderness ecosystems. In addition, NPS policies also direct park managers to eliminate the presence of exotic species where "prudent and feasible" (NPS 2001a). Various elements of the wilderness character of the North Cascades Complex include outstanding opportunities for solitude and the ability to pursue recreational opportunities such as hiking, climbing, and sport fishing in a primitive and unconfined manner. The wilderness characteristics and values of the North Cascades Complex, however, are not completely devoid of human disturbance.

In addition to the formal network of managed trails, there are many informal routes and social trails that are readily visible to the wilderness user. These informal trail networks access a variety of backcountry destinations including mountaineering routes, scenic vistas, and mountain lakes. Many backcountry lakes that contain fish have visible patterns of human use (such as social trails) around readily accessible portions of the riparian zone, including inlet and outlet streams.

Some backcountry users, including anglers, occasionally key in on the patterns of social trails around a lake as a means of determining whether or not a lake contains fish. Those who are opposed to the mountain lake fishery often point to the social trails around lakes that contain fish as evidence that the mountain lake fishery contributes to a derogation of wilderness aesthetics. This is because trails around lakes detract from a sense of solitude and provide evidence of human manipulation (for example, stocking) of natural processes. Those who favor the mountain lake fishery point out that other users besides anglers are also responsible for social trails around lakes. They argue that stock (horses, mules, llamas) users, in particular, are responsible for some of the most egregious examples of trails and riparian zone impacts.

Some representative opinions expressed during the public scoping period are presented below.

> Assess the lakes as scientific reference areas for other management agencies in other parts of the Cascades. Discuss role of NPS policies in light of the broader Cascades ecosystem. As directed by Congress the Park is to be kept in Wilderness and pristine condition and the surrounding National Forests are managed for multiple uses.
>
> Let the wilderness be wild, let the high alpine lakes or all the lakes in the wilderness live and evolve on their own without human fish stocking.
>
> Acknowledgement of a wilderness overlay was completely ignored in the presentation I attended . . . what are the effects on wilderness from present stocking?

Visible signs of human disturbance aside, the interpretation of the *Wilderness Act* as legislation protecting natural processes versus protecting an esthetic experience is currently the subject of litigation and court debate.

HUMAN HEALTH

HUMAN HEALTH CONCERNS WITH POTENTIAL CONSUMPTION OF CHEMICALLY TREATED FISH

This plan/EIS considers the use of antimycin for chemical treatment. Antimycin is registered as Fintrol® with the U.S. Environmental Protection Agency (EPA) for use by state and federal fish and wildlife agencies in fish management projects. According to the PICOL database maintained by Washington State University, Fintrol Concentrate - Antimycin A (EPA No. 39096-2) is presently registered for use as a fish toxicant in Washington (WDFW 2004). As described in the “Alternatives” chapter of this plan/EIS, antimycin works by entering the fish gills and irreversibly blocking cellular respiration (Rosenlund and Stevens 1992). Antimycin, when used in proper concentration, is less harmful to nontarget aquatic animals than the recommended concentration of rotenone, the only other piscicide that is registered with the EPA for general use in the United States (Finlayson et al. 2002; NPS 2000b). Antimycin is also considered to be harmless to waterfowl, mammals, and humans at concentrations needed to control fish, and following application, it degrades rapidly (Rosenlund and Stevens 1992). Antimycin is the only control method, other than dewatering, that is capable of complete eradication of fish populations (WDFW 2004). It also controls all post-embryonic life stages and can be selective by fish species (Finlayson et al. 2002). For all of these reasons, antimycin would be the preferred toxicant for fish removal.

Concern has been expressed about the potential effects on human health from consumption of treated fish. An undated Fintrol® Concentrate label from Aquabiotics Corporation (see appendix L) recommends that “pending the conclusion of studies now in progress, fish killed with antimycin A should not be consumed by man or animals.” Although specific effects are unknown, antimycin reportedly has little impact on nontarget species such as humans. Antimycin is toxic to target species at extremely low concentrations, so only very small amounts of the chemical are needed to kill fish. The concentration of antimycin necessary to remove fish is considered to be harmless to humans, and antimycin breaks down very quickly in a fish’s body, reducing the likelihood of contamination if fish are caught and consumed (NPS, R. Zipp, pers. comm., 2003; Rosenlund and Stevens 1992).

The potential for human consumption of fish treated with antimycin is low or non-existent due to the closing of lakes to be treated, educational materials posted, the extremely low dose used for treatment, and treatment of discharged waters. These mitigation measures are further described in appendix I, and the analysis of impacts is described in the “Human Health” section in the “Environmental Consequences” chapter.

HUMAN HEALTH CONCERNS WITH POTENTIAL EXPOSURE TO METHYL-MERCURY AND PERSISTENT ORGANIC POLLUTANTS THROUGH CONSUMPTION OF EXPOSED FISH

There is a small but growing body of evidence indicating that the water quality of lakes in the North Cascades Complex is being tainted by persistent organic pollutants (such as polychlorinated biphenyl [PCB], dichlorodiphenyl-trichloroethane [DDT], toxaphene, and methyl-mercury). These anthropogenic compounds enter the atmosphere as volatile contaminants and can be transported for long distances. The compounds can be deposited through condensation and precipitation. The highest amounts of contaminated snowfall are often deposited at high elevations in glaciers and snowfields. Meltwater washes these pollutants into mountain lakes and streams, where they can become absorbed and accumulated in the food chain. This process has been well documented in the Canadian Rockies where researchers there found that contaminant levels in fish tissues are well above the residue guidelines for piscivorous wildlife such as otters, bald eagles, and ospreys (Blais et al. 1998).

DDE is an environmentally persistent metabolite (or residue) of DDT.

Out of concern that bioaccumulation of persistent organic pollutants and methyl-mercury might be occurring in the mountainous national parks in Washington, in the summers of 2002 and 2003, researchers with the U.S. Geological Survey - Water Resources Division collected and analyzed fish tissues from select high-elevation lakes in the North Cascades Complex, including Upper Wilcox, Skymo, Green, and Copper lakes. Fish tissue samples from Green Lake were found to contain concentrations of methyl-mercury and organochlorine contaminants that approached the threshold for human consumption. Twenty-eight different organochlorine compounds were analyzed for, and only two were observed: total PCBs and DDE (dichlorodiphenyldichloroethylene). Both of these compounds were detected at concentrations below the Food and Drug Administration Action Levels for fish tissue of 2 and 5 milligrams per kilogram (mg/kg), respectively. The 5 mg/kg Action Level is for total DDT, which includes DDE (EPA 2004). However, the average PCB concentrations in fish from all sampled North Cascades Complex lakes exceeded EPA's screening value (0.02 mg/kg for recreational anglers) for elevated cancer risk (EPA 2004). Methyl-mercury concentrations were likewise below EPA criteria; however, in at least one lake, concentrations were approaching the methyl-mercury tissue screening values of 0.31–0.47 mg/kg (EPA 2004). Exceedance of these recommended values suggests that long-term consumption of fish (two 8-ounce meals per month every year over a 70-year lifetime) from such places may increase the likelihood of developing cancer or chronic systemic effects. The researchers caution that these fish tissue results are preliminary, and additional sampling is needed. Nonetheless, the results indicate that contaminant levels in Green Lake in the North Cascades Complex are similar to levels found in Green Lake in Seattle (P. Moran, pers. comm., 2004).

SOCIOECONOMIC RESOURCES

The North Cascades Complex is less than a four-hour drive from six major metropolitan and economic centers: Bellingham, Everett, Seattle, Tacoma, Spokane, Washington; and Vancouver, British Columbia. The North Cascades Complex is located in the eastern portion of Whatcom County and extends into eastern Skagit County and northern Chelan County. The unincorporated communities of Diablo and Newhalem in Whatcom County are located along State Route 20, which runs east-west through the Ross Lake National Recreation Area and portions of Whatcom and Skagit counties. The Lake Chelan National Recreation Area is located at the south end of the North Cascades Complex, entirely within Chelan County and bordering Okanogan County on the east. The unincorporated community of Stehekin is in the Lake Chelan National Recreation Area (see “Map 1” or “Map 2” located in the envelope that accompanied this document).

Most urban development in Whatcom and Skagit counties is located at the western end of the counties. Areas adjacent to the North Cascades Complex are primarily rural. The towns and cities that travelers pass through on the way to the North Cascades Complex include Burlington, Sedro-Woolley, and Hamilton. The unincorporated communities of Rockport and Marblemount are located along State Route 20, which connects to Interstate 5 (I-5) in Burlington. Most visitors from the Puget Sound area would travel north on I-5 and east on State Route 20 to reach the North Cascades Complex. Highway 530 extends east from I-5 at Arlington and travels through Oso, Hazel, and Darrington before joining State Route 20 at Rockport to the north. Arlington lies 4 miles east of I-5 at Highway 9 and Highway 530. Towns along State Route 20 east of the North Cascades Complex include Mazama, Winthrop, Twisp, Carlton, and Methow. State Route 20 is closed in the winter. The Lake Chelan National Recreation Area and the community of Stehekin are accessible by trail, small plane, boat, and passenger-only ferry.

In rural areas with natural resources (for example, timber resources), small communities are at times built around certain industries (such as logging or agriculture-related manufacturing) dependent on the available natural resources of the area. As long as the industry endures, the community survives and may grow; however, if an industry on which a community is highly dependent suffers, the community’s economy likely suffers as well. In natural resource-dependent areas along the west coast of the United States, communities have had to diversify their economies due to decreases in timber production. Local economies have grown in the tourism, service, and trade sectors. This phenomenon has also occurred in communities surrounding the North Cascades Complex.

Many small communities were built around natural resource-based industries such as logging.

Tourists to North Cascades Complex contribute to the economy by spending money at local and regional businesses on lodging, gasoline, food, permits and fees, and souvenirs. These expenditures create jobs and income that, in turn, create secondary economic impacts. Businesses patronized by tourists are typically in the services and retail trade industry categories. In the counties of Whatcom, Skagit, and Chelan, trade and services together account for 53% of employment (WESD 2003).

Some specifics about the economies of the three counties in which the North Cascades Complex is located are provided in the following sections.

WHATCOM COUNTY

GENERAL BACKGROUND, LAND USE, AND POPULATION

Whatcom County is bounded by the Canadian border to the north, Okanogan County to the east, Skagit County to the south, and the Strait of Georgia and Bellingham Bay to the west. The North Cascades Complex encompasses the eastern portion of the county. The city of Bellingham's population is 57,830—the highest of all cities in the county. Population growth has been driven primarily by in-migration (Whatcom County 1998). Bellingham is located in the western third of the county along with the other more-populated areas of the county.

During the period 1980 to 1990, Whatcom County's population grew less than 2% per year on average. During the next decade (1990 to 2000), the average growth rate increased to approximately 3% per year. In 2002, approximately 174,500 people lived in Whatcom County, reflecting an approximate 1% growth rate from the previous year. The Washington State Office of Financial Management projects that the county's population could be approximately 189,100 by the year 2012; Whatcom County projects a 2015 county population of 220,366 people (Whatcom County 1998; OFM 2002). Whatcom County's population represents approximately 3% of the Washington State population. As a whole, the county grew faster than the state between 2000 and 2001 and also during the period 1990 to 2000.

County population demographics and in-migration affect land use patterns. Areas influenced by seasonal residency include Point Roberts, Birch Bay, and the Paradise Lakes / Peaceful Valley area near Kendall. Many seasonal homeowners are permanent residents of Canada. In addition to vacation homes shaping the culture and demography, older populations are increasing in size in Whatcom County relatively faster than in the state of Washington as a whole, especially the 50 to 69 and over-75 age groups (Whatcom County 1998).

Future land use patterns in Whatcom County would likely be influenced by existing future development patterns, existing transportation systems, local and international economics, and environmental and natural resource land constraints. Agriculture and forestland would likely continue to dominate the landscape (Whatcom County 1998). Whatcom County has a major university; access to markets in British Columbia, Puget Sound, California, Alaska, and Asia; and an existing transportation infrastructure (including seaport facilities, rail, air, and highway) (Whatcom County 1998).

As shown in table 27, income and the value of housing in Whatcom County are slightly lower compared to Washington State as a whole.

Economy and Industry Trends

Whatcom County's economy was traditionally based in agriculture, fishing, forestry, and mining. Throughout the 1950s, these four industries represented more than 25% of the county's total employment. Since the 1960s, increased manufacturing, trade, services, and government economic activities have diversified the county's natural resource base.

Whatcom County also gained highway access in the early 1970s. Interstate 5 provided freeway access to Whatcom County urban areas from British Columbia, Canada, and the central Puget Sound region. Western Washington University's enrollment has increased, making the university one of the county's major employers.

Currently, Whatcom County's economy is centered on agriculture/food processing, fishing/fish processing, timber/wood processing, manufacturing, retail trade, and tourism. Resource-based industries in recent years have come to account for just under 6% of county employment (Whatcom County 1998).

Beginning in 1989, Canadian investment in Whatcom County manufacturing grew. British Columbia manufacturers developed operations there to take advantage of lower operating costs and access to U.S. markets. Canadian influences contribute substantially to the county's economy (Whatcom County 1998); for example, the Canadian manufacturing investment has been estimated at over $86 million, creating over 1,300 direct jobs.

The large Canadian consumer population in Whatcom County, among other effects, has created a relatively large retail sector. In 1994, estimates indicated that over 25% of county employment was related to Canadian consumer activity, and 30% to 40% of county retail activity depended on the Canadian shopper (Whatcom County 1998).

Table 27: Whatcom County Demographics

Measure	Whatcom County	Washington State
Population, 2001 estimate	170,849	5,987,973
Population percent change, April 1, 2000–July 1, 2001	2.4%	1.6%
Population, 2000	166,814	5,894,121
Population percent change, 1990–2000	30.5%	21.1%
Persons 65+ percent change, 2000	11.6%	11.2%
Housing units, 2000	73,893	2,451,075
Median value of owner-occupied housing units, 2000	$155,700	$168,300
Median household money income, 1999	$40,005	$45,776
Per capita money income, 1999	$20,025	$22,973

Source: Census 2003.

TOURISM

Whatcom County tourism has developed into a $70 million industry, employing approximately 2,500 people. The county's natural scenic attractions draw 6 million to 7 million visitors a year (Whatcom County 1998). The county's resort areas include Birch Bay, Point Roberts, the Mount Baker winter recreational area, and Semiahmoo Spit.

LOCAL BUSINESSES

A variety of businesses provide recreational services and supplies in the vicinity of the park. Some include sporting goods stores, angling stores, and small convenience stores.

SKAGIT COUNTY

GENERAL BACKGROUND, LAND USE, AND POPULATION

Skagit County is located between the cities of Vancouver, British Columbia, and Seattle, and connects the San Juan Islands and North Cascades via State Route 20. Skagit County's *2000 Comprehensive Plan* (Skagit County 2000) focuses on current and proposed land use. The county uses four land use designations to apply regulations and standards: (1) Natural Resource Lands, (2) Urban Growth Areas, (3) Rural Areas, and (4) Open Space. National park and recreation lands, along with wilderness, were designated as Open Space. The county is comprised of 130,853 acres of national park and recreation land and 83,539 acres of wilderness (Skagit County 2000).

Skagit County's population, which represents less than 2% of Washington State's population, grew slightly faster than the state's population during the period 2000 to 2001, similar to Whatcom County's population growth. The county population also grew faster than the state during the period 1990 to 2000. Skagit County has more residents over the age of 65 when compared to the state as a whole, and has a lower income and lower median value of housing units when compared to Washington State (table 28).

TABLE 28: SKAGIT COUNTY DEMOGRAPHICS

Measure	Skagit County	Washington State
Population, 2001 estimate	105,247	5,987,973
Population percent change, April 1, 2000 – July 1, 2001	2.2%	1.6%
Population, 2000	102,979	5,894,121
Population percent change, 1990–2000	29.5%	21.1%
Persons 65+ percent change, 2000	14.6%	11.2%
Housing units, 2000	42,681	2,451,075
Median value of owner-occupied housing units, 2000	$158,100	$168,300
Median household money income, 1999	$42,381	$45,776
Per capita money income, 1999	$21,256	$22,973

Source: Census 2003.

Economy and Industry Trends

The Upper Skagit Indian Tribe owns and plans to develop a substantial amount of property at the Bow Hill Road / I-5 interchange. The Tribe's existing casino at Bow Hill Road already generates 550 jobs, with an annual payroll of $12 million. Tribal members hold over 70 of the 550 jobs. The Tribe is planning additional commercial and economic development that will tie into the Tribe's culture, history, and relationship with the land (Skagit County 2000). The Bow Hill Road / I-5 interchange is approximately 70 miles from the west entrance of the North Cascades Complex.

One of the county's objectives is to provide for small-scale recreational and tourism uses that could help to diversify the economy of rural Skagit County. In the eastern portions of the county, many of the existing towns and rural residential areas have experienced a downturn in economic activity related to natural resources, similar to what has occurred in Whatcom County. In the North Cascades Complex and along the scenic North Cascades Highway (State Route 20), the eastern portions of the county have begun to experience an evolution from a primarily natural resource-based local economy to one that also includes services to tourists.

Tourism

During the summer months, approximately 300,000 visitors travel through eastern Skagit County. During the winter, State Route 20 closes, tourist travel drops substantially, and local economic activity decreases (Skagit County 2000).

Local Businesses

A variety of businesses provide recreational services and supplies in the vicinity of the park. Some include sporting goods stores, angling stores, and small convenience stores.

CHELAN COUNTY

General Background, Land Use, and Population

Chelan County is bordered on the north by Skagit, Okanogan, and Snohomish counties. On the east, Douglas County borders Chelan County, and its southern neighbor is Kittitas County. To the west, King County borders Chelan County. Chelan County is one of the largest counties in the state of Washington. Approximately 90% of the county is public land, including Lake Chelan National Recreation Area, Wenatchee National Forest, Glacier Peak Wilderness Area, Chelan Butte Wildlife Refuge, and parts of North Cascades National Park. The Columbia River and the Entiat River also run through Chelan County. The Columbia River is a water source for drinking and irrigation.

Chelan County comprises 2,921 square miles and seven growth areas, including Mission Urban, Chelan Urban, Entiat Urban, Greater Wenatchee Area Urban, Cashmere Urban, Leavenworth Urban, and Rural and Resource Lands.

Chelan County is also one of the fastest growing counties in Washington State. As of 2000, Chelan County had a total population of 62,200 people. Between 1980 to 1990, the population grew 16%, and between 1990 and 2000, the population grew 27%. Fifty-five percent of the population growth occurred in the cities. The enrollment in the three school districts in Chelan County increased by 19% to 25% (Chelan County 2000).

The medium household income in 1999 was $37,316 (table 29), and approximately 12% of residents lived below the poverty level.

ECONOMY AND INDUSTRY TRENDS

The county's unemployment rate was approximately 9% in the year 2000. Most jobs in the county are in government, educational services, or retail trade. In 2000, employment in the manufacturing sector was 8% of the county's total employment (Chelan County 2003). Although agricultural production is also a large economic presence in Chelan County, the county is comprised of 90% public lands.

LOCAL BUSINESSES

A variety of businesses provide recreational services and supplies in the vicinity of the park. Some include sporting goods stores, angling stores, and small convenience stores.

TABLE 29: CHELAN COUNTY DEMOGRAPHICS

Measure	Chelan County	Washington State
Population, 2001 estimate	67,133	5,987,973
Population percent change, April 1, 2000–July 1, 2001	0.8%	1.6%
Population, 2000	66,616	5,894,121
Population percent change, 1990–2000	27.5%	21.1%
Persons 65+ percent change, 2000	13.9%	11.2%
Housing units, 2000	30,407	2,451,075
Median value of owner-occupied housing units, 2000	$148,400	$168,300
Median household money income, 1999	$37,316	$45,776
Per capita money income, 1999	$19,273	$22,973

Source: Census 2003.

CURRENT ESTIMATED SPORT FISHING EXPENDITURES TO THE REGIONAL ECONOMY

The estimated number of visitors to North Cascades Complex in the 2003 season who engaged in mountain lake sport fishing is estimated to be approximately 1,000. This estimate is from one year of surveying visitors (NPS 2003c) who applied for a backcountry permit. The number is consistent with the park's observations for the 2003 season that those who engage in sport fishing represent 10.5% of backcountry permits that were issued to users going to camps or zones near the 91 lakes in the study area. It is also consistent with the 1992 Visitor Services Project that estimated 12% of Lake Chelan National Recreation Area visitors engaged in sport fishing (NPS 1992). Day use of the study area lakes appears minimal compared to overnight use; therefore, day-use expenditures are most likely also a small part of overall angler expenditures (see the section titled "Visitor Use and Experience" in this chapter). The WDFW estimates that approximately $49.79 per trip is expended by those who sport fish in the state (WDFW 1996).

Using this estimate of expenditures, and the angler use of the study area, the total annual direct expenditures of anglers to the North Cascades Complex is approximately $50,000. If assuming that 20% of all backcountry overnight users engaged in sport fishing, the annual direct expenditures would be slightly higher.

IMPLAN is a software program with region-specific input/output data sets that is used to estimate economic impacts from projects. A study area (including Whatcom, Skagit, and Chelan counties) was modeled in IMPLAN, and regional input/output data for each industry was calculated to get an estimate of current economic contributions of those who use the study area for sport fishing. Since sport fishing is not a standard IMPLAN sector, the model used a combination of economic sectors: agricultural, forestry, and fishery services; sporting and athletic goods; food stores; eating and drinking establishments; and hotels and lodging places. Multipliers for employment, output, and labor income were then estimated for the sport-fishing industry. When factoring in the relationship between output, jobs, and income from sport fishing associated with the North Cascades Complex mountain lakes fishery, the direct economic output ($50,000 annually) within the three-county area would most likely support one to two associated direct jobs and $10,000 in direct labor income on an annual basis (IMPLAN, Copyright Minnesota IMPLAN Group, Inc.).

The total (direct plus secondary) spending that can be attributed to sport fishing in the North Cascades Complex represents, at most, 0.001% of total retail sales in the three-county area, and 0.006% of total retail sales in the combined unincorporated areas of the three counties (WDOR 2003). This means that revenues from mountain lakes angling account for roughly $1 out of every $100,000 spent in the three-country region. In comparison to the three-county economy as a whole, these expenditures are not substantial.

CURRENT ESTIMATED SPORT FISHING EXPENDITURES TO THE LOCAL ECONOMY

There are no fishing guide services in the North Cascades Complex; however, private local outfitters take visitors on trips to backcountry lakes in the North Cascades Complex in part, and at times, to fish. Typically, other recreational activities are also offered on these trips. While there is very little local data on angler expenditures, business owners have provided some information on the relative importance of sport fishing. Interviews with proprietors of local businesses on the west side of the North Cascades Complex that cater to anglers indicate that mountain lakes fishing in the North Cascades Complex is very limited and accounts for a negligible portion of revenues. A variety of factors appear to contribute to the limited use, including access difficulties, perception of fishing as being prohibited, and a general lack of knowledge that many mountain lakes in the North Cascades Complex contain fish.

A very different perspective of the socioeconomic importance of backcountry lakes was provided by the proprietor of the Stehekin Valley Ranch in Lake Chelan National Recreation Area. When asked how their business would be affected if sport fishing opportunities were reduced or eliminated, they said they would lose visitors because fishing provides an important incentive for visitation. Fishing mountain lakes is very important for their pack trips and day trips. They estimate that 28 guests per day visit their ranch from June through August. Regarding pack trips, the Rainbow Lake fishery is very important. Day trips to Coon Lake are also an important part of their business, especially during the spring and fall seasons when the high country cannot be reached. Stehekin Valley Ranch believes that 90% of their guests visit Coon Lake because the lake is an easy hike, and it is only 1 mile from the road and 3 miles via horseback from the Stehekin Valley Ranch. The ranch estimates that 25% of its guests fish Coon Lake in the spring, and 25% of the guests fish the Stehekin River in the summer. In the fall, 40% of the guests fish, mostly in the Stehekin River, but many again turn to Coon Lake. Overall, they believe that stocking should continue everywhere that it is economically feasible (Stehekin Valley Ranch, C. Courtney, pers. comm., 2003).

Coon Lake is a popular fishing destination in the Stehekin Valley.

The 1995 *Lake Chelan General Management Plan* offers yet a different perspective of the reasons people visit the Stehekin area. The *General Management Plan*, using data from 1992, identifies sightseeing, hiking, wildlife observation, photography, and bicycling as the primary visitor activities for people visiting Stehekin. The 10%–12% of visitors who do visit the area and engage in sport fishing is a relatively small proportion of the annual visitation to the area (NPS 1995).

NORTH CASCADES COMPLEX MANAGEMENT AND OPERATIONS

RESOURCES MANAGEMENT

Resource management in the North Cascades Complex is a critical component of overall park operations. NPS staff in the Resource Management Division focus on two broad categories of management actions: science and stewardship. Scientific pursuits include inventorying and monitoring park resources and conditions as they change through time due to various natural and human influences. Stewardship in the North Cascades Complex primarily involves minimizing and mitigating the impacts of human actions on natural and cultural resources. The emphasis on stewardship is preservation and maintenance of natural processes, as opposed to specific features.

The WDFW plays a central role in managing fish and wildlife populations in the North Cascades Complex, particularly in the recreation areas where hunting and cooperative management of game are authorized as part of its enabling legislation. Regarding fishery management, the NPS defers to WDFW regulations for setting creel limits and for management (including stocking) of game fish in the reservoirs, running waters, and mountain lakes.

In recent years, resource management activities in the North Cascades Complex have focused heavily on improving the baseline knowledge of both natural and cultural resources, as part of a national effort by the NPS to inventory and monitor park resources as part of its Natural Resource Challenge initiative. The initiative is an effort to improve management decisions by enhancing knowledge and understanding of NPS resources. In support of this effort, Congress is providing funding to the NPS for inventorying, monitoring, restoration, research, and education. The North Cascades Complex aquatics program has been focusing on

- monitoring salmon in the Skagit River and its tributaries
- monitoring benthic macroinvertebrate streams and lakes throughout the North Cascades Complex
- systematically inventorying the distribution and abundance of amphibians in terrestrial and aquatic habitats to improve knowledge of amphibian distributions
- inventorying stream resident fish populations and stream habitats
- developing long-term stream and lake monitoring protocols

EDUCATION AND INTERPRETATION

The goal of the Interpretation Program in the North Cascades Complex is to provide for public enjoyment and promote understanding, awareness, and appreciation of the natural, cultural, scenic, and scientific values of the North Cascades Complex and the surrounding ecosystem. Education and interpretation are also used as tools to solicit visitor participation in reducing resource impacts. In addition, the resources of the North Cascades Complex are used as an educational base for a wide variety of age groups.

The National Park Service maintains visitor centers in Newhalem (shown in photo), Sedro-Woolley, and Marblemount.

The Interpretation Program staff maintain a state-of-the-art visitor center in Newhalem, a Wilderness Office in Marblemount, and a visitor center in Stehekin at the historic Golden West Lodge. Visitor information is also provided at the NPS headquarters office in Sedro-Woolley and at the U.S. Forest Service Station in Glacier. Interpretive programs are provided throughout the developed areas in the North Cascades Complex.

Educational materials include bulletin boards, wayside exhibits, interpretive displays, and various trail guides and handouts for visitors. A few of these guides discuss sport fishing as part of a suite of recreational opportunities available to visitors. The guides also educate park visitors about the mountain lake fishery in an attempt to promote an awareness of the ecological issues and concerns that are being addressed at length in this plan/EIS.

MAINTENANCE

The Maintenance Division in the North Cascades Complex performs many visitor use and development services related to boating, camping, hiking, sightseeing, education, and interpretation. The division maintains buildings, utilities, roads, and the extensive backcountry trail and camp network.

CONCESSIONS

Commercial uses in North Cascades Complex include concessions and Commercial Use Authorization (CUA) holders. Most of the commercial uses involve backcountry guiding services that operate under CUAs. In addition, there are seven rafting outfitters that operate on the Skagit River, and four outfitters that provide paddling (kayak and/or canoe) services on Ross Lake. One-third to one-half of all CUA holders are nonprofit organizations.

Concessions differ from CUA holders because they take place under a competitively awarded contract with the NPS. CUA operations take place entirely on NPS land, and funds are exchanged essentially within the park. They often own structures and buildings on NPS land. The only concession service on the west side of the park is Ross Lake Resort on Ross Lake. The resort originally centered around fishing on Ross Lake, but as the quality of the fishery on Ross Lake declined in the 1970s and 1980s, the Ross Lake Resort expanded its services to accommodate nonangling clientele. Services now include lodging, water taxis, and boat rentals. There are three concessions in the community of

Stehekin, including the Stehekin Lodge, the House that Jack Built (a community craft cooperative), and MacGregor Mountain Outdoor Supply. The latter provides a variety of outdoor equipment, including fishing supplies.

There are no concessions or CUA holders in the North Cascades Complex that provide services exclusively related to sport fishing in mountain lakes, although fishing is part of many activities that are provided by backcountry guide and stock services as part of the overall trip experience. For example, Cascade Corrals, a horse-packing service based out of Stehekin, operates under a CUA and provides day trips to Coon Lake. On these trips, sport fishing is one of many activities that take place as part of the overall trip experience.

ENFORCEMENT

The Visitor Safety and Resources Protection Division shoulders a variety of management responsibilities that include Search and Rescue and law enforcement. Regarding law enforcement, the philosophy is to use the most minimum tool necessary to gain compliance with federal and state laws and regulations. The NPS law enforcement jurisdiction in the North Cascades Complex is proprietary, meaning that it reserves the right to regulate as a landowner, but the state of Washington retains predominant rights. Proprietary jurisdiction allows the NPS to assimilate state law in accordance with 36 CFR Part II. NPS Law Enforcement Rangers and WDFW Game Wardens jointly enforce regulations governing fish and wildlife. The most common legal violation in the North Cascades Complex is failure to secure a permit for backcountry camping. Poaching of plants and wildlife is also a common problem.

PARK FUNDING

As shown in table 30, funding for operations and programs in the North Cascades Complex has remained relatively steady over the past 10 years at approximately $5.5 million per year. Referred to as “base funding,” each year NPS units receive funds to, among many things, operate the park, pay salaries, undertake maintenance projects, and administer natural and cultural resource protection programs. Overall, base funding for NPS units has not increased substantially and is expected to remain at current levels in the future.

CURRENT COST OF THE FISHERY MANAGEMENT PROGRAM

The costs of continuing to manage mountain lakes under alternative A would be primarily associated with stocking, very limited monitoring, and project oversight. These actions would cost approximately $18,000 per year and primarily be borne by the WDWF (WDFW, M. Downen, pers. comm., 2004). See the “Management and Operations” section in the “Environmental Consequences” chapter for the estimated costs to implement each alternative.

TABLE 30: ESTIMATED BASE FUNDING FOR THE NORTH CASCADES COMPLEX*

Fiscal Year	Estimated Increase in Base Funding	Estimated Base Funding
1993	No base increase	$4,864,000
1994	$400,000 base increase	$5,264,000
1995	No base increase	$5,264,000
1996	No base increase	$5,264,000
1997	No base increase	$5,264,000
1998	$275,000 base increase	$5,539,000
1999	No base increase	$5,539,000
2000	No base increase	$5,539,000
2001	No base increase	$5,539,000
2002	No base increase	$5,539,000
2003	No base increase	$5,539,000
2004	Requested $350,000	$5,889,000

Note:

* Base funding would not be the primary source of funds for implementation of the fishery management plan. For more details on cost of implementation, see the "Management and Operations" section in the "Environmental Consequences" chapter.