Chapter 2 – Skagit River Basin Characteristics

2.0 Overview

The Skagit River Basin is located in northwest Washington State and has a total drainage area of 3,115 square miles. The Skagit River originates near the 8,000-foot level of the Cascade Mountains in British Columbia, Canada and flows south and then west to the Skagit delta where it discharges through two distributaries – the North Fork and South Fork – to Skagit Bay. The major cities on the Skagit River delta – Sedro-Woolley, Burlington, Mount Vernon, and LaConner – lie about 60 miles north of Seattle.

The basin extends about 110 miles in a north-south direction, reaching 28 miles into British Columbia, and approximately 90 miles in an east-west direction between the crest of the Cascade Mountains and Puget Sound. (USACE, 2009) It is the largest basin tributary to Puget Sound, and the largest basin in Washington outside the Columbia River. (NRSC, 2006)

The Skagit River floodplain contains about 22,000 acres east (upstream) of Sedro-Woolley (RM 22.4) and 74,000 acres west (downstream) of Sedro-Woolley. Principal tributaries of the Skagit River are the Sauk and Baker which contribute 59%, and the Cascade Rivers. Seattle City Light operates three hydroelectric dams on the Upper Skagit River (Ross, Diablo, and Gorge), and Puget Sound Energy operates two hydroelectric dams on the Baker River (Upper Baker and Lower Baker). (USACE, 2009)

The Lower Skagit is primarily located within Skagit County; however, a small portion of the northwestern part of Snohomish County is also included. This portion of Snohomish County is mostly outside the urban growth area. It is the largest basin tributary to Puget Sound, and the largest basin in Washington outside the Columbia River. (NRSC, 2006)

The principal land uses in the study area are cropland, forestland, and urban and built-up areas. Both dairy farming and row cropping are widespread in the watershed. Other agricultural operations include berries, bulbs and tree nurseries. The three main population centers are Mount Vernon, Burlington, and Sedro-Woolley. Much of the low lying areas are diked and drained, and several pump stations discharge water from the drainage districts into the Skagit River. The lower Skagit is approximately 284,302 acres in size. The watershed is 71% privately owned and 29% publicly owned. Major resource concerns are streambank erosion, impaired water quality, forest health issues, invasive weeds, and urban encroachment on agricultural areas. (NRSC, 2006)

The current population of Skagit County is approximately 119, 534. The Census Bureau's Population Estimates Program (PEP) produces July 1 estimates for years after the last published decennial census (2000). Existing data series such as births, deaths, and domestic and international immigration, are used to update the decennial census base counts. PEP estimates are used in federal funding allocations, in setting the levels of national surveys, and in monitoring recent demographic changes.

With each new issue of July 1 estimates, PEP revises estimates for years back to the last census. Previously released estimates are superseded. Revisions to estimates for prior years are usually due to input data updates, changes in methodology, or legal boundary changes. (Census, 2010)

~~Skagit County has abundant resources of water, with the Samish and Skagit Rivers within its borders. These rivers have a history of flooding, however, and have caused extensive damage to major sections of the county, affecting the county's economy, resources, and way of living. This chapter describes the watershed area. (Skagit County, 1989)~~

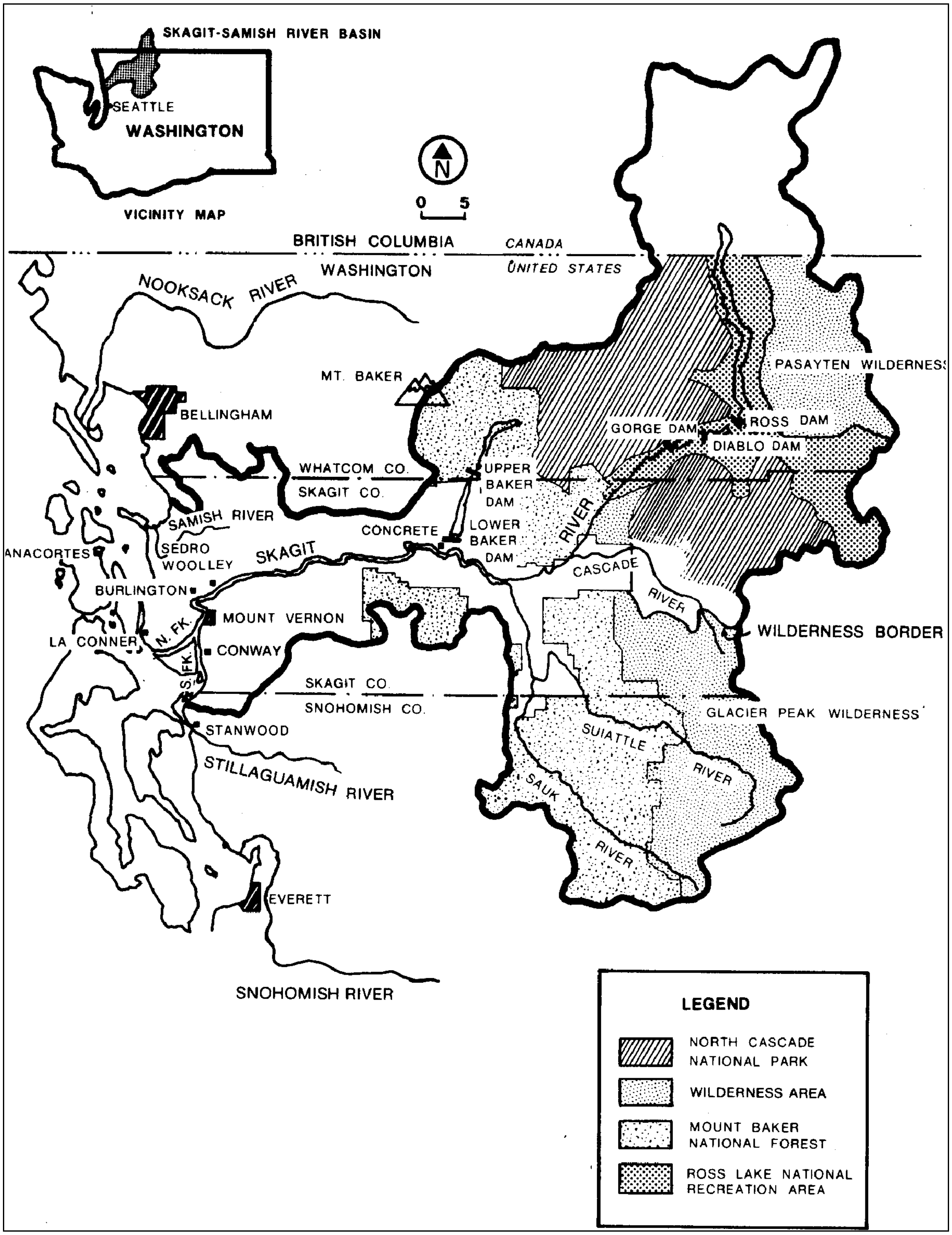
~~2.1 Description of the Skagit River Watershed~~

~~This watershed is located in the northwest corner of Washington State. The entire Skagit River basin has a drainage area of approximately 3,093 square miles, which includes its headwaters in British Columbia. It is the largest basin tributary to Puget Sound, and the largest basin in Washington outside the Columbia River. (NRCS, 2006)~~

~~The basin extends about 110 miles in the north-south direction, and about 90 miles in the east-west direction between the crest of the Cascade Range and Puget Sound. The northern end of the basin extends 28 miles into Canada. The Skagit River falls rapidly from its source at elevation 8,000 feet to an elevation of 1,600 feet at the United States-Canadian border. Within the first 40 miles south of the international border, the river falls 1,100-feet, and the remaining 500-foot fall is distributed along the 95 miles of the lower river. (PIE, 2008)~~

~~Immediately downstream from Mount Vernon, the river divides into two principal distributaries, the North Fork and the South Fork. These two distributaries carry about 60 percent and 40 percent, respectively, of the normal flows of the Skagit River into Puget Sound, although these ratios change during a large flood event (USACE, 2008).~~

Figure 2.1 – Skagit River Basin



(USACE, 2009)

2.1 The Skagit River - Skagit Wild and Scenic River System

The Skagit Wild and Scenic River System, located in both Skagit and Snohomish counties, was established by Congress in 1978 (Sec 703 of PL 95-625, 11/10/1978.) It includes the following river segments:

- The Skagit River, from the pipeline crossing at Sedro-Woolley, upstream to and including the mouth of Bacon Creek
- The Cascade River, from its mouth to the junction of its North and South Forks
- The South Fork of the Cascade River, to the boundary of the Glacier Peak Wilderness Area
- The Suiattle River, from its mouth to the boundary of the Glacier Peak Wilderness Area at Milk Creek
- The Sauk River, from its mouth to its junction with Elliott Creek
- The North Fork of the Sauk River, from its junction with the South Fork of the Sauk to the boundary of the Glacier Peak Wilderness Area

The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law 90- 542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in their natural and free-flowing condition for present and future generations. The Act is focused on safeguarding the special character of these rivers, while also recognizing the potential for their appropriate use and development.

The Skagit Wild and Scenic River System feeds into Puget Sound and features one of the largest bald eagle concentrations in the lower 48 states. Covering over 158 miles, the river system is known for its fisheries resources, rugged canyons, glacier-covered mountains, and densely forested slopes.

The Skagit Wild and Scenic River is located in a unique and beautiful place, largely untouched, yet within a reasonable drive from a number of major metropolitan areas. Development in the Skagit River basin has been increasing since the river was designated in 1978. Management of the Skagit Wild and Scenic River must be consistent with the Wild and Scenic Rivers Act, Section 10(a), which requires the protection and enhancement of the values that caused the Skagit Wild and Scenic River to be included in the National Wild and Scenic Rivers System.

This climate and the Skagit Wild and Scenic River designation have provided abundant opportunities for working in partnership at the watershed scale to fulfill river stewardship responsibilities. The convergence of such abundant natural resources and the growing popularity of the area creates a challenge in balancing use and enjoyment with the long-term sustaining this unique ecosystem. Forest Service river management strategies must push beyond geographical, legal, administrative, political, and personal boundaries to find effective solutions that will sustain the unique features of this river system. (Snohomish, 2009)

2.2 Physical Characteristics

~~2.2~~ 2.2.1 Topography

The Skagit River originates in a network of narrow, precipitous mountain canyons in Canada and flows west and south into the United States where it continues 135 miles to Puget Sound. The crest of the Cascades forms the eastern boundary of the basin with altitudes ranging up to 8,000 feet. From the Cascades, the river flows through gorges of glacier peaks to lower mountains, where its banks are heavily wooded with conifers, meanders around island stands of cottonwoods and alders, and then expands into the farm delta of the Skagit Valley. The valley varies in width from less than 1 mile in upper reaches to about 2 miles at Sedro-Woolley to more than 15 miles at the broad delta outwash plain, which encompasses 68,000 acres of floodplain. At Fir Island, the river divides into two principal distributaries of nearly equal length. During the usual range of river discharge, about 60 percent of the flow is carried by the North Fork and 40 percent by the South Fork. The entire floor of the Skagit River Valley and the deltas of the Samish and Skagit Rivers comprise the flood plain. The major portion of the flood plain within the study area is developed farmsteads, large portions of the commercial area of Mt. Vernon, and the urban area of Burlington; the remainder is mostly uncleared bottom land and wetlands. (USACE, 2008)

~~A major portion of the Skagit River basin lies on the western slopes of the Cascade Range. Most of the eastern portion of the basin is mountainous land above an elevation of 6,000 feet. The two most prominent topographical features in the basin are Mount Baker on the northern side of the basin at an elevation of 10,778 feet, and Glacier Peak in the southern portion of the basin at an elevation of 10,568 feet. In the eastern portion of the basin, 22 peaks are above an elevation of 8,000 feet. The upper reaches of nearly all tributaries are situated in precipitous steep-walled mountain valleys. The Skagit River flows in a l-mile- to 3-mile-wide valley from Rockport to Sedro-Woolley. In this section, the valley walls are moderately steep timbered hillsides with few developments. Below Sedro-Woolley, the valley falls to nearly sea level and widens to a flat, fertile floodplain formed by continual river sediment transport and also by significant volcanic activity from Glacier Peak, most notably from a catastrophic lahar event about 5,900 years ago that deposited between 0.5 and 0.7 cubic miles of sediment extending to the present location of Samish Bay to the northeast, and La Conner and Stanwood to the southeast (Beget, 1982; Dragovich, Grisamer and others, see Washington State Department of Natural Resources, Open File Report 98-8). Additional more recent Glacier Peak volcanic activity from about 1,800 years ago may have added lahar material to the lower valley (Dragovich and Grisamer, Dec 1998). The lahar/flood plain joins the Samish valley along the northeast side of the valley and extends west through Mount Vernon to La Conner and south to the Stillaguamish River. (PIE, 2008)~~

~~2.3~~ 2.2.2 Geology

Prior to the glacial epochs, the Sauk and Suiattle Rivers formed a part of the Stillaguamish drainage basin.

During the glacial ages, the Skagit basin was much more heavily mantled with local ice than at present. In addition, the Skagit delta was overrun by an invasion of ice from Canada. The Canadian ice sheet, augmented by local glaciers in the State of Washington, pushed southward through the Puget Sound area between the Cascade Range and the Coast Ranges until it passes latitude 47 N., and established its terminal moraine a short distance north of Centralia, nearly 170 miles south of the Canadian border. The Skagit River was blocked not only by this tremendous glacier near its mouth, but also further upstream near the town of Concrete where a large local glacier came down the Baker River valley.

The dam formed by one of the glaciers forced the Skagit River to cross a pass, now occupied by the lower Sauk valley, into the Suiattle River basin. During a portion of this glacial epoch, while the ice dam held, the entire Skagit River above Concrete poured across the Skagit-Suiattle divide and thence down the Stillaguamish River. The ice dam probably held for many thousands of years and during the time the Skagit-Suiattle pass was rapidly cut down to form a regular river channel. After the glacial epoch, the Skagit River returned to its old lower valley and was able to capture the Suiattle and Sauk Rivers from the Stillaguamish River through the new channel cut through the Skagit-Suiattle divide.

In the Puget Sound region there were great changes in elevation during the glacial epochs. Geologists have stated that during various geologic eras this region probably has been as much as 1,000 feet higher and perhaps 300 feet lower than it is at the present time. During the various glacial actions the stream valleys became deeply filled with glacial drift. It may be nearly 1,000 feet to bedrock in the old river channel on the Skagit delta. Construction projects have shown about 110 feet of depth to bedrock at Gorge Dam and about 30 feet to bedrock at Ross Dam. (USGS, 1961)

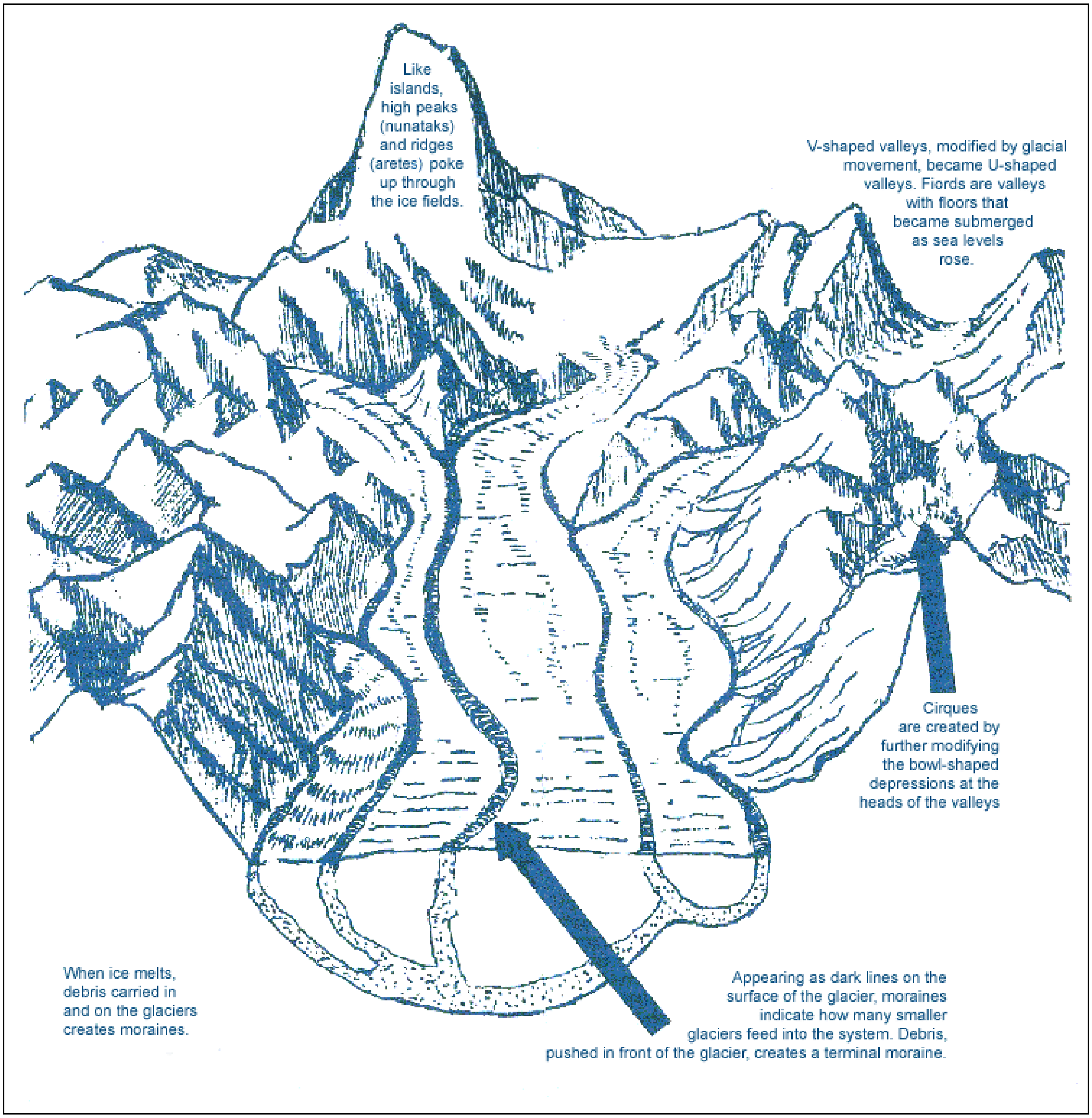
The Baker River Valley - Prior to the first glacial epoch, the Baker River undoubtedly lay in a broad, deep valley. The river surface near Concrete was then a few hundred feet lower than its present surface in that section. The upper portion of the Baker River basin must have, at times, been invaded by lava flow from Mt. Baker. Probably there are in places many layers of alternate river deposits and lava. Possibly the upper portion of the valley is filled to a great depth with these layers.

At the beginning of the first glacial epoch, the glaciers from Mt. Baker forced the Baker River water over to the east side of the valley. During the Admiralty epoch, the Baker Valley was filled with glacial drift, as was the Skagit in the Concrete – Sedro-Woolley region. On the retreat of the Admiralty ice, the east side of the Baker Valley was the first to be opened, just as it was the last to be closed at the beginning of the Admiralty epoch. The great outflow of water from the melting glacial ice marking the end of the Admiralty epoch, cut a river channel along the east side of the old pre-glacial valley. In places, this valley cut into the bed rock on the east hillside of the valley.

During the Puyallup inter-glacial epoch, the valley was widened and deepened considerably. Erosion in the Admiralty till was greatly hindered, however, by the slow erosion in the new, highly elevated rock cuts on the east side of the valley. Probably lava flows from Mt. Baker invaded the upper part of the valley.

Stetattle Creek glacier forced the Skagit River across a rocky point opposite the mouth of the Stetattle Creek. Thunder Creek glacier caused enormous changes in Skagit Valley opposite the mouth of Thunder Creek. The great Thunder Creek glacier, of which the present Boston glacier is only a tiny remnant, forced the Skagit against the north side of its valley. Changes in the glacier and the river caused such an amount of erosion that a great section of the country on the north side of Skagit River is a sort of plateau covered with hills and river channels. Since the Vashon glacial epoch, Thunder Creek for a portion of its course near its mouth, has been cutting a new rock channel. Its pre-Admiralty and Puyallup inter-glacial channels are, no doubt, buried under a great quantity of glacial materials.

Figure 2.2 – Diagram of a Glacier



(U.S. Forest Service)

The Dalles - The Dalles was formed by the Skagit River when it was forced across a rocky point by the Baker glacier. Elevated portions of this rocky channel are water worn in a downstream direction, indicating that the mouth of the Skagit was open at the time. The field investigation determined neither the glacial epoch during which the Dalles was formed, nor whether the channel was first cut at the beginning or end of a glacial period. The Baker River, however, at one time formed a dam across the Skagit River, while the mouth of the Skagit Valley was open.

It seems likely therefore that the Baker River glacier, during each glacial period, dammed the Skagit, both before and after the Puget Sound glacier dammed the mouth of the valley.

Uplift And Subsidence Of The Land, And Its Effect On River Drainage, Taking Into Account Glacial And Inter-Glacial Epochs - During the Admiralty glacial epoch, the valleys in the Puget Sound Basin had been filled with glacial drift. On the retreat of this glacier, or sometime thereafter in the Puyallup inter-glacial epoch, the land rose almost 1,000 feet. This elevation of the land, caused most of the Skagit Basin streams to rapidly remove practically all of Admiralty drift and start cutting in the underlying bed rock. In this connection it is interesting to note the remains of valley drift fill on the north side of Skagit Valley between Concrete and Sedro-Woolley. The bench can be seen in nearly all places where the hillside has been cleared by logging. From the valley floor in the neighborhood of Lyman, the long bench of glacial drift can be seen lying on the north hillside at an elevation of probably 500 or 600 feet. This long bench is very likely continuous on both sides of the valley from Concrete to Sedro-Woolley. If the Baker River glacier dammed the Skagit Valley to a higher elevation than the Puget Sound glacier, then the slope of this drift fill is downstream toward Sedro-Woolley, and indicates the slope of the water flowing westward between the Baker and Puget Sound glacial dams.

During the Puyallup inter-glacial epoch, great valleys were eroded in the Admiralty till in the main Puget Sound Basin. These valleys are now occupied by Puget Sound waters, except where they have been filled by drift during the Vashon glacial epoch and by later river deposits in the form of deltas.

A great deal of additional cutting must have been done, during the Puyallup period, in the bed rock channel between the present mouth of the Suiattle River and the town of Sauk. As before stated, the flow was south through this valley during the Admiralty and Vashon epochs, and north during the Puyallup inter-glacial and past Vashon epochs. It seems likely that during the Puyallup interglacial epoch, this portion of the Sauk River bed was cut down to correspond to the grade of the upper Sauk and lower Skagit. There is a possibility, however, that bed rock is much nearer the surface in this section of the river under the old Skagit-Suiattle Pass, than either upstream of downstream from there.

The great elevation of the Puget Sound region and of the Cascade Mountains, during the Puyallup inter-glacial epoch disappeared near the close of that epoch or at the beginning of the Vashon ice invasion. If the lowering was at the beginning of the Vashon glacial epoch, it may have been due in part, or entirely, to the weight of the Vashon ice. Streams in the region under discussion were rediverted by the Vashon ice as in the Admiralty glacial epoch. After a comparatively short stay, the Vashon glaciers retreated, and stream beds, to a large extent, were reoccupied. It may be estimated roughly that the Skagit Valley has been free from Vashon ice for somewhere between 15,000 and 50,000 years.

After the retreat of the Vashon glaciers, the Puget Sound region was at one time nearly 300 feet lower than at present. The time has been short since the last glacial epoch; also the elevation of the land has been from 1,000 to 1,300 feet less than during the Puyallup inter-glacial epoch. For these reasons, the streams have not been able to cut down to the solid rock beds which they occupied during the Puyallup inter-glacial epoch. In the lower portion of the basin, the old stream beds are below sea level and of course cannot be reoccupied until the land is again greatly elevated.

From the foregoing, it can readily be seen why the steam valleys, even in rock canyons, are deeply filled with river material and glacial drift. It is probably nearly 1,000 feet to bed rock in the old river channel on the Skagit delta. It is known to be 111 feet to bed rock at the City of Seattle's Gorge Creek power site, and 30 feet at their Ruby Creek dam site. The City of Seattle's core borings, in conjunction with the probable depth of bed rock on the Skagit delta, show the gradual decrease in depth of material. This gradual decrease in depth of material may be expected in the Skagit and tributaries, except where original beds have not been reoccupied, such as Baker River, Thunder Creek, the site of the old Skagit-Suiattle Pass, now the lower Sauk channel, and the old Sauk channel underlying Darrington. (USGS, 1923)

~~The eastern mountainous region of the upper Skagit River basin consists of ancient metamorphic rocks, largely phyllites, slates, shales, schists, and gneisses together with intrusive granitic rocks and later andesitic lavas and pyroclastic deposits associated with Mount Baker and Glacier Peak. (USACE, 2008)~~

~~The valleys are generally steep-sided and frequently flat-floored. Valley walls are generally mantled with a mixture of rocky colluvium, and, to a considerable elevation, by deposits of continental and alpine glaciation. These deposits are a heterogeneous mixture of sand and gravel together with variable quantities of silt and clay depending on the mode of deposition (USACE, 2008)~~

~~Some of these deposits are susceptible to land sliding when saturated. The floodplain of the Skagit River below Concrete is composed of sands and gravels that diminish to sands, silts, and some clays further downstream. Below Hamilton, fine-grained floodplain sediments predominate. The Baker River valley in the vicinity of Baker Lake is geologically quite different from most of the other Skagit tributaries. This is largely due to the influence of Mount Baker, a volcanic cone rising to an elevation of 10,778 feet, that sets astride the western boundary of the Baker River basin. (PIE, 2008)~~

~~Present bedrock exposures adjacent to Ross Lake consist of Chilliwack sediments, volcanics and granitics, Skagit gneiss, and Nooksack group phyllite (USACE, 2008). The continental ice movement and mountain glaciers sculpted the basic geological forms and rock types into the major landforms that are recognizable today. A large mass of metamorphic rock, known as the Skagit gneiss, forms the foundation rock for all three of the Skagit River Project plants (USACE,~~

~~2008). The age of its parent strata is presumed to be Paleozoic. The resistance to erosion provided by the massive gneiss is undoubtedly the reason for the narrow gorge of the Skagit River where the dams are located. Alpine glaciers have contributed to the steepness of the valley sides and to the depth of the valley bottoms. Over ten thousand years ago, the upper Skagit Valley and the peaks were severely glaciated, removing not only the soil but much of the loose rock (USACE, 2008 and PIE, 2008)~~

~~Many river channels created during the glacial melt have continued to aggrade, and as a result of that glacial action, the bedrock bottoms of most canyons are covered with glacial alluvium. (USACE 2008 and PIE, 2008)~~

~~2.4~~ 2.2.3 Soils and Sediment

The soils in the lower watershed are dominantly formed in material that has been influenced by glacial deposits or glacial scour of bedrock. The till can be hard and dense, and loose and unsorted when modified by meltwater. Glaciofluvial sediment transported and deposited by meltwater includes coarse, gravelly and cobbly outwash along stream courses, sandy outwash on outwash plains, and fine sediments in glacial lakes. Floods of fast-moving meltwater deposited thick beds of coarse outwash along stream channels now occupied by the Skagit River. Soils in the higher elevation have a thin veneer of glacial drift and colluvium over bedrock. Thin layers of volcanic ash and loess of varying thicknesses overlie most of the soils. At higher elevations it occurs as discrete surficial layers that are primarily volcanic ash with silty textures.

The climate pattern in this watershed provides a low risk of wind erosion but water erosion can be a concern on steeper slopes and when surface residue is removed by intensive crop/forest management practices or wildfire in the lower precipitation areas. (NRSC, 2006)

~~Predicted rates of bed accumulation for 100 years in the Skagit River system vary in depth from 4 feet at the mouth of the 2 distributaries, the North and South Forks of the Skagit River, to 2 feet at Mount Vernon (USACE, 2008). The 2 feet of depth continues upstream to Burlington (USACE, 2008). The river annually transports about 3,000,000 tons of sediment of mostly glacial origin (Mastin, Schwartzenberger and Perry, 2008). Size of bed material, as determined by field observations and samples, varies from 1/4-inch to 3/4-inch gravel and coarse sand at Mount Vernon to medium and fine sand near the river mouths. From Burlington to Concrete, channel sediments are predominantly fine-to-coarse sands, gravels, and cobbles together with small quantities of silt and clay (USACE, 2008 and PIE, 2008)~~

2.2.4 Water Quality

Skagit County began its water quality baseline monitoring plan in 2001 to meet the requirements of the Growth Management Act – RCW 36.70A. The County's plan has recently been extended to include monitoring water quality trends in the County's agricultural areas as well.

The Skagit River is designed for aquatic life uses as core summer salmonid habitat (WAC 173-201A-602). This use is characterized by use from June 15 to September for salmonid spawning or emergence, or adult holding; use as important summer rearing habitat by one or more salmonids; or foraging by adult and sub-adult native char. Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing, and migration by salmonids. Water quality standards (i.e., temperature, dissolved oxygen, and turbidity) are established based on this aquatic life use designation. In addition, the Skagit River is designated for primary contact recreational uses, all water supply uses, and all miscellaneous uses.

Currently, areas of the Skagit River are designated as a category 5 for presence of PCBs and high pH and Skagit Bay is listed for fecal coliform. Several sloughs in the delta are designated as category 5 for fecal coliform, pH, dissolved oxygen, and temperature. A category 5 designation means that data show that these water quality standards were violated and there is no total maximum daily load (TMDL) or pollution control plan in place. Category 5 sites become a part of the Washington Department of Ecology's 303d list submitted to the EPA. In addition, several of the tributaries to the Skagit River (including Nookachamps Creek, Carpenter Creek, and Hansen Creek) are on the 303d list for temperature and dissolved oxygen (WDOE, 2008). The North Fork, South Fork, and several tributaries of the Skagit River are designated as category 4A for fecal coliform. A designation of 4A means that this water body has a pollution problem that is being addressed by an approved TMDL. The Skagit River is designated as a category 2 for PCBs and 2,3,7,8 TCDD. A designation of category 2 means that data show that these standards are of concern in this water body. (USACE, 2008)

Data collected from Skagit County's 2007 monitoring report indicate that many Skagit County streams, within and outside of the agricultural areas, do not meet state water quality standards for fecal coliform, temperature, and/or dissolved oxygen. Most of the substandard water quality occurs in tributaries to the Skagit River and in the Samish Basin, while the Skagit River itself meets standards on most occasions (Skagit County Public Works, 2007)

The upper reaches of the Skagit meet state water quality standards. There are two areas in the upper Skagit basin that are on the Ecology's 303d list for temperature and fecal coliform (WDOE, 2008a).

- Temperature: The Ecology's 2008 303d list (designated as a category 5) includes the mainstem Skagit within WRIA 4 (Upper Skagit) for temperature near river mile 55. Also, Finney and Jackman Creeks were listed as a waters of concern (category 2) for temperature. According to the Skagit County 2007 Water Quality Monitoring Report 5 out of the 8 sites that were monitored above Sedro Woolley exceeded state standards of a 7 day maximum of 16C, all of these sites are tributaries. The mainstem Skagit monitoring station in this station did not exceed the 7 day maximum.

- Fecal coliform: The Ecology's 2008 303d list includes Prairie Creek for fecal coliform. Prairie Creek is a tributary of the Sauk River near the town of Darrington. Another tributary, Red Cabin Creek, has been designated as a category 2 (waters of concern). According to the Skagit County 2007 Water Quality Monitoring Plan 2 out of the 8 sites exceeded state standards for fecal coliform. Both of these sites are tributaries.

- Dissolved Oxygen: There a no waters in above Sedro Woolley designated as category 5 (303d list) by Ecology for dissolved oxygen, however there are three small tributary creeks, Finney, Siuattle, and Goodell, designated as a category 2 (waters of concern). According to the Skagit County 2007 Water Quality Monitoring Plan only one of the monitoring sites, which was on a tributary, upstream of Sedro Woolley had an average DO that fell below the state standard of 9.5 mg/L.

- Sediment/Turbidity: There are no 303d listings or category 2 designations for the Upper Skagit Basin by Ecology for turbidity. However, logging practices in the Upper watershed contribute, along with other other landuse factors, contribute to turbidity both downstream and in Skagit Bay. The SWC's Strategy Application found degraded conditions in the Upper Skagit sub-basins, particularly for sediment supply and riparian conditions, but not to the same extent as the lower Skagit, primarily because of less intense human development and the extensive amount of federally protected land. During periods of summer warm temperatures and rain, high turbidity in the Skagit River can be attributed further to a natural condition of "glacial flour". Glacial flour consists of clay-sized particles of rock suspended in the river water, giving the water a cloudy appearance. Heavy turbidity in Skagit Bay is largely due to excessive siltation from the surface water runoff of the Skagit and Samish Rivers that results from flood events and glacial melt.

- Chemical Contamination/Nutrients: There are no 303d listings or category 2 designations for chemical contamination (which are mainly pesticides) and/or nutrients by Ecology for the Upper Skagit River or any of its tributaries. However, plots of agricultural land occur along the Upper Skagit River from Sedro Woolley to Marblemount (just upstream of the confluence with the Cascade River) so elevated nutrient loads are likely. The Skagit County 2007 Annual Monitoring Report's most upstream station is just upstream of the town of Hamilton. Values of total nitrogen, total phosphorus, and ammonia are 0.08, 0.02, and 0.02 mg/l respectively, which is quite low in comparison with some of the downstream monitoring sites on the mainstem Skagit and its tributaries and sloughs.

(USACE, 2009)

~~2.5~~ 2.2.5 Climate, Precipitation, and Temperature

The study area has a mild, wet, maritime climate caused by air masses originating over the Pacific Ocean which influence both the temperature and precipitation regimes. During the winter, the Skagit Basin, lying directly in the storm path of cyclonic disturbances from the Pacific, is subject to a definite rainy season, with numerous storms often in quick succession. During the short summers, the weather is warm and relatively dry as the winter low pressure system is displaced by a semi permanent high pressure system. The mean length of the growing season is 193 days.

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Precipitation over the basin varies greatly from a mean annual amount of 32 inches in the vicinity of the mouth of the Skagit River which lies in a topographical rain shadow, to an average of 180 inches or more on the higher elevations of the Cascade Range. Mean annual snowfall varies from 4.4 inches at Anacortes to 647 inches at Mount Baker Lodge. Average winter temperatures vary from 26.9°F at Mt. Baker Lodge (4,150 feet) to 34.5°F at La Conner, and average summer temperatures vary from 56.7°F at Mt. Baker Lodge to 61.7°F at La Conner.

Models from the UW Climate Impacts Group indicate that over the next century the Pacific Northwest area will likely see a trend toward wetter warmer winters and hotter dryer summers in response to climate change. However, these large scale models have difficulty resolving mountain climates such as the cascades so exact sceneries are difficult to predict. Currently the UW climate group is working on meso-scale models that may be able to resolve smaller scale climates (UW Climate Impacts Group, 2008).

It is speculated that the Skagit River system may see higher flows in the winter as the majority of the precipitation would fall as rain and not snow, and lower flows in the summer due to lack of rain and snow melt. Initially, glacial melt would increase, but over time would decrease as the glacier retreats. Not only would this scenario lead to a different flow regime then what is seen in the Skagit today, but will likely lead to increases in water temperatures within the river (Hamlet and Lumberd, UW Climate Impacts Group, pers. comm.).

In addition to changes in precipitation and air temperatures, sea level rise in Puget Sound is predicted to be 6-50 inches in the next century. This range incorporates higher sea level rises expected in the south around Olympia and Tacoma and lower expected rises in the north around Friday Harbor and Bellingham Bay (UW Climate Impacts Group, 2008). (USACE, 2008)

~~The major factors influencing the climate of the Skagit River basin are terrain, proximity of the Pacific Ocean, and the position and intensity of the semi-permanent high and low pressure centers over the north Pacific Ocean. The basin lies about 100 miles inland from the moisture supply of the Pacific Ocean. Westerly air currents from the ocean prevail in these latitudes bringing the region considerable moisture, cool summers, and comparatively mild winters.~~

~~Annual precipitation throughout the basin varies markedly due to elevation and topography. Major storm activity occurs during the winter when the basin is subject to rather frequent ocean storms that include heavy frontal rains associated with cyclonic disturbances generated by the semi-permanent Aleutian Low. During the summer months, the weather is relatively warm and dry due to increased influence of the semi-permanent Hawaiian high pressure system. (PIE, 2008)~~

~~2.5.1 Temperature~~

~~The mean annual temperature for stations in or near the basin varies from 40.l degrees Fahrenheit (°F) at Mount Baker Lodge to 50.7°F at Concrete. Normal monthly temperatures vary in January from a low of 26.9°F at Mount Baker Lodge to a high of 3 9. 1 °F at Anacortes, and in August from a low of 56.7°F at Mount Baker Lodge to a high of 64.7°F at Diablo Dam. The temperature extremes recorded in the basin are 109°F at Newhalem and -14°F at Darrington Ranger Station. A phenomenon known as the Pineapple Express can cause Pacific Northwest wintertime temperatures to rise to the upper 50s or warmer, such as happened in December 1990 when temperatures in the Seattle area reached 63 degrees. A Pineapple Express occurs when the jet stream dips into the tropics and then carries a large batch of tropical (Hawaiian) moisture northeast into the Pacific Northwest during the winter. This causes wet and warm weather, a common cause of lowland flooding episodes. (PIE, 2008)~~

~~2.5.2 Precipitation~~

~~The locations of precipitation stations in the Skagit River basin are shown on Figure 1. Average annual precipitation over the Skagit basin varies by about 150 inches. Mean annual precipitation is 40 inches or less near the mouth of the Skagit River and in the portion of the basin in Canada that lies in topographic rain shadows. Average precipitation of l80 inches or more falls on the higher elevations of the Cascade Range in the southern end of the basin and over the higher slopes of Mount Baker. The annual precipitation over the basin above the town of Mount Vernon, as recorded at Ross Dam, Diablo Dam, Newhalem, Upper Baker Dam, Concrete, and Sedro-Woolley, averages 71 inches with approximately 75 percent of this amount falling during the 6-month period of October-March. The mean monthly precipitation at stations in or near the basin ranges from 0.96 of an inch in July at Anacortes to 17 inches in December at Mount Baker Lodge. The mean annual precipitation at Baker Lake and Diablo Dam is 102.88 inches and 77.07 inches, respectively. The maximum recorded precipitation for one month was 4l.95 inches at Silverton (south of Darrington) in January 1953. Storm studies indicate that 5 to 6 inches of rainfall in a 24-hour period have occurred over much of the basin. Information on storms and flooding in the basin is discussed. (PIE, 2008)~~

~~2.5.3 Snowfall~~

~~Snowfall in the Skagit River basin is dependent upon elevation and proximity to the moisture supply of the ocean. The mean annual snowfall at stations in the vicinity of the basin varies from 6.2 inches at Anacortes to 525.3 inches at Mount Baker Lodge; with a maximum recorded value~~

~~of 1,140 inches at Mount Baker Lodge during the July 8, 1998 through June 1999 season. Snow surveys have been made in the vicinity of the Skagit River basin since 1943. (PIE, 2008)~~

~~2.5.4 Wind~~

~~Surface wind speeds in the basin are the result of the pressure gradient between high and low pressure cells, storm intensity, and topographic effects. Prevailing winds in the lower basin are generally from the southerly quadrant from September through May, and from the northerly quadrant from June through August. In the upper valleys above Concrete, the airflow is subject to a topographic funneling effect and is generally up the valley in winter and down slope in summer. A diurnal change in direction often occurs in the summer. Occasionally in the winter, cold continental air from eastern Washington or eastern British Columbia will flow through mountain passes creating cold east winds down the valley. In the winter season, storm winds will vary from 20 to 30 miles per hour (mph). During extreme events, winds will exceed 60 mph for short durations with 100 mph gusts occurring over mountain peaks. A common producer of high winds in this area is the Pacific Northwest chinook, which results from high and low pressure areas colliding overhead. Two notable chinook wind storms of recent history hit northwest Washington in December 1996 and in December 2003. The 1996 chinook brought winds up to 60 to 70 mph, with gusts to 80 mph. Trees were blown onto power lines causing extensive power outages, and in some cases trees were snapped off at the ground. The 2003 chinook sustained winds of 45 to 50 mph, with gusts to 65 mph. (PIE, 2008)~~

2.2.6 Volcanoes

The Cascade Range extends more than 1,000 miles forming an arc-shaped band extending from Southern British Columbia to Northern California lying roughly parallel to the Pacific coastline and includes 14 major volcanic centers. The Cascade Range is made up of a band of thousands of very small, short-lived volcanoes that have built a platform of lava and volcanic debris. Rising above this volcanic platform are a few strikingly large volcanoes that dominate the landscape. The Cascades volcanoes define the Pacific Northwest section of the "Ring of Fire", a fiery array of volcanoes that rim the Pacific Ocean.

Many of these volcanoes have erupted in the recent past and will most likely be active again in the future. Given an average rate of two eruptions per century during the past 12,000 years, these disasters are not part of our everyday experience.

Skagit County's Eastern boundary follows the crest of the Cascade Range. While there are no volcanic peaks within Skagit County, Mount Baker lies just to the North in Whatcom County and Glacier Peak lies just to the South in Snohomish County. Geologic evidence indicates that both Mount Baker and Glacier Peak have erupted in the past and will no doubt erupt again in the foreseeable future. Due to the topography of the region and the location of drainage basins and river systems, eruption events on either Mount Baker or Glacier Peak resulting in lahar's, pyroclastic flows, tephra or ash fall, and lava flows could severely impact portions of Skagit County.

Eruptions in the Cascades have occurred at an average rate of 1-2 per century during the past 4,000 years, and future eruptions are certain. Seven volcanoes in the Cascades have erupted within the past 225 years. Four of those eruptions would have caused considerable property damage and loss of life if they had occurred today without warning – the next eruption in the Cascades could affect hundreds of thousands of people.

The most recent volcanic eruption events within the Cascade Range occurred at Mount Saint Helens in Washington (1980-1986) and at Lassen Peak in California (1914-1917).

Lahars are the primary threat and present the greatest hazard to Skagit County resulting from volcanic activity at either Mount Baker or Glacier Peak.

The river valleys and associated floodplains of the Baker River, Skagit River, Sauk River, and Suiattle River along with their associated tributaries are all especially vulnerable to the effects of large-scale lahars and associated flooding that will no doubt result from a large lahar.

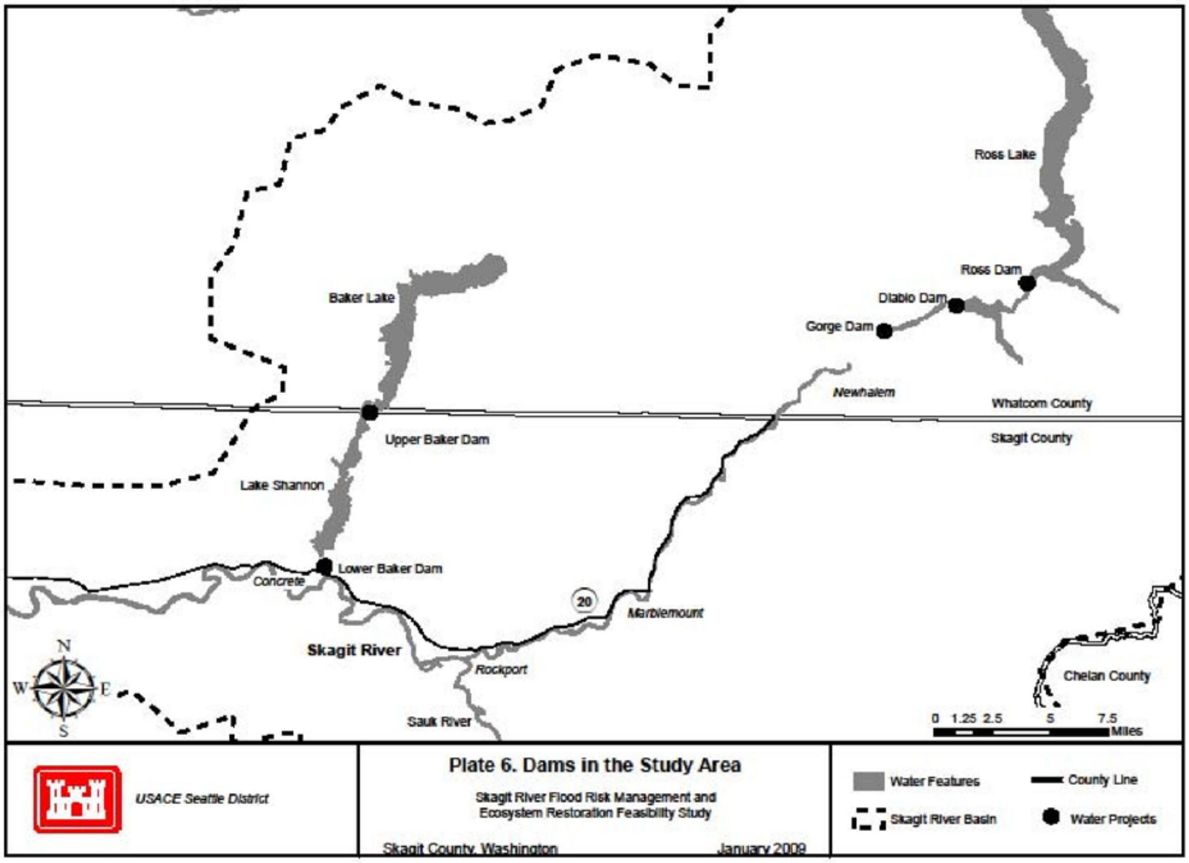
Lahars traveling down the Baker River drainage could rapidly raise the level of Baker Lake leading to overtopping and/or damaging the Upper Baker Dam thereby leading to possible overtopping and/or damage to the Lower Baker Dam resulting in severe flooding of portions of the Town of Concrete and surrounding upriver areas of the Skagit River floodplain.

As demonstrated during the 1980 Mount Saint Helens eruption, the hydraulic power of fast-moving lahars and debris flows is astonishing. Sandbags and other "normal" flood fight measures will not be effective to provide any type of protection for such an event. (Skagit County, 2008a)

~~2.6~~ 2.2.7 Dams

The Skagit River basin includes three dams located on the mainstem Skagit River (Gorge, Diablo and Ross), and two dams located on the Baker River (Lower Baker and Upper Baker). Gorge Dam was completed as a wooden structure in 1924, and replaced with a concrete dam in 1960. Diablo Dam was completed in 1930, at the time the tallest dam in the world at 389 feet. The first level of Ross Dam (300 feet tall) was completed in 1940, and the second and third levels were both completed in 1949 bringing the dam's total height to 540 feet. Lower Baker Dam was completed in 1925, creating Lake Shannon. Upper Baker Dam was completed in 1959, increasing the size of the naturally occurring Baker Lake. Regulation of the Skagit River using 120,000 acre-feet of flood control storage at Ross Dam began in 1954, and regulation of the Baker River using 74,000 acre-feet of flood control storage at Upper Baker Dam began in 1980 (Information in this paragraph sourced from publicly available hydroelectric licenses, other public records/studies, and Corps of Engineer documents).

Figure 2.3 – Dams in the Study Area



(USACE, 2009)

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~~(Beget, Dragovich and others, 1982 – 2006). Prior to 5,900 years ago, the floodplain terminated near the present-day location of Burlington, and the sea level was about 20 feet lower than today (Dragovich and McKay; Dethier, Beget and others, 1982-2000). Subsequent lahars as recent as 1,800 years ago may have added material to the flood plain, either directly or through sediment transport over time (Washington Department of Natural Resources, Open File Report 2000-6). (PIE, 2008)~~

~~2.7 Streamflow Characteristics~~

~~The Skagit River basin is subject to rain and snowmelt runoff during the fall, winter, and spring. Spring snowmelt runoff is caused predominantly by melting of the winter snowpack, and is characterized by a relatively slow rise and long duration evidenced by the higher mean high flows for the months of April through June. Some minor contribution to the rate and peak of the snowmelt is occasionally provided by warm spring rains, but the spring rain-on-snow impact is usually not significant. Highest mean monthly snowmelt discharges are usually reached in June. The resulting runoff occasionally inundates low areas adjacent to the river but rarely reaches the major damage stage. The maximum-recorded spring snowmelt discharge at Mount Vernon was 92,300 cubic feet per second (cfs) in April of 1959. Power reservoirs are normally refilled during the annual spring snowmelt runoff; and as a result, the spring peak discharges are generally reduced. The Skagit River and all of its major tributaries usually have low flows during August and September after the high elevation snowpack has melted and the baseflow has partially receded, even though operation of the upper basin reservoirs increases flows over historic numbers. With the advent of heavy precipitation in the fall and winter, the Skagit River experiences a significant flow increase. Floods and the highest daily and highest instantaneous peak discharge of the year usually occur during this period. Heavy rainfall and warm winds during typical 1- to 3-day winter storms cause streamflows to rise rapidly in a matter of hours to flood levels. Streamflows recede rapidly within hours after the storms have moved eastward through the region, although base flows and basin soil moistures usually remain high for several days. Several minor rises usually occur each winter, while major floods are more intermittent. The Skagit River, which receives the effect of the initial lifting of Pacific Ocean air over the Cascade Range, varies in seasonal streamflow throughout the basin, generally due to the basin's heavy winter precipitation, spring snowmelt runoff, dry summers and topographical and elevation differences. The average annual runoff at the following stations reflects the runoff variation throughout the basin: Skagit River at the Newhalem stream gage - 51.1 inches, Sauk River near Sauk stream gage - 83.0 inches, Baker River at Upper Baker - 13 1.0 inches, Baker River at Concrete stream gage - 121.8 inches, and Skagit River near Mount Vernon - 73.2 inches. The 999-square-mile watershed above Ross Dam, located in the lee of western mountains that shield the basin from winter storms, has an annual runoff of only 45.6 inches. Maximum and minimum extremes in recorded annual runoff at Mount Vernon during the 1941-1999 period are 16,752,595 acre-feet (in l991) and 7,608,893 acre-feet (in l944) or 101.6 and 46.1 inches, respectively, for the 3,093 square-mile basin. (PIE, 2008)~~

~~2.8~~ 2.3 Environmental & Biological Resources

~~2.8.1~~ 2.3.1 Vegetation on the Upper Basin

Approximately 90% of the Upper Skagit Basin is located within National Forest or National Park property. Of this area, 56% falls within Mount Baker National Forest and 31% falls within North Cascades National Park (NCNP). Large tracts of both old-growth and secondary-growth coniferous forests dominate the landscape in these areas. Four major forest types lie within the Upper Skagit Basin in NCNP: Western Hemlock Forest (0 to 2,000 feet in altitude), Pacific Silver Fir Forest (2,000 to 4,000), Mountain Hemlock Forest (4,000 to 5,500), and Subalpine forest (5,000 to 7,000+) (NPS 2008). The majority of all forest types are dominated by coniferous species. Species common to the higher elevations include mountain hemlock (Tsuga mertensiana), subalpine fir (Abies lasiocarpa), Engelmann spruce (Picea engelmannii), noble fir (Abies procera), and Alaska yellow-cedar (Palicourea croceoides). Other common species that generally occur at lower elevations and along the rivers and tributaries are Western hemlock (Tsuga heterophylla), Western red cedar (Thuja plicata), Pacific silver fir (Abies amabilis), Douglas fir (Pseudotsuga menziesii), Western white pine (Pinus monticola), Sitka spruce (Picea sitchensis), and some deciduous species such as black cottonwood (Populus trichocarpa), alpine willow (Salix petrophila), cascade willow (Salix cascadensis), paper birch (Betula papyrifera), bigleaf maple (Acermacrophyllum), bitter cherry (Prunus emarginata), Sitka alder (Alnus viridis ssp. sinuate), red alder (Alnus rubra), and red osier dogwood (Cornus sericea) (NPS 2008).

The dense expanses of forests found in the Upper Skagit Basin are thought to be particularly susceptible to climate change. Current models have predicted warmer year-round temperatures, wetter winters, and dryer summers for the Pacific Northwest region. Such changes should increase rates of photosynthesis and forest growth (Rapp, 2004). Increased woody vegetation and subsequent woody debris may lead to higher fire occurrence as the increased fuel load will readily cure during the longer, drier, and warmer summers. Existing forests will also likely be more frequently attacked by insects and diseases as warmer winters reduce the natural kill of insects and pathogens. In addition, a warming climate will also allow lower altitude species to expand their range upward in altitude and latitude allowing them to invade areas beyond their current distribution and displace existing species. It has been predicted that exotic species will also accelerate their range expansion into areas made newly available by the warming climate. The forest communities in the Upper Skagit Basin will likely change significantly overtime.

The habitat found along the Skagit River in the northwestern portion of the Upper Skagit Basin consists almost entirely of conifer dominated forest intermixed with deciduous trees and shrubs. Further downstream, from Sedro-Woolley to Marblemount, the riparian environment alternates from patches of agriculture, to urban landscapes with narrow greenbelts, to larger patches of primarily deciduous forests typical of the lowland floodplain. These deciduous forests contain trees such as black cottonwood and big leaf maple and shrubs such as willows and salmonberry (Rubus spectabilis). The three major tributaries of the Upper Skagit River; the Baker River (including Lake Shannon and Baker Lake), the Sauk River, and the Cascade River, are dominated by riparian areas lined with deciduous tree and shrubs. The frequency of agriculture and urbanization increases in a downstream direction, with the Lower Skagit Basin being dominated by agricultural and urban land uses.

Large woody debris (LWD) is common in the Skagit River upstream of Burlington (Pentec 2002). There is no transport of LWD from above the dams by either natural or human processes. LWD exists along the shoreline, both in water and as recruitable trees on the bank. Concentrations of LWD can be found at the upstream end of islands, such as those at river miles 35 and 58, or the entrance to side channels, such as at river mile 64.

Burlington Northern Santa Fe Bridge (1995)
(Courtesy of the U.S. Army Corps of Engineers)

~~2.8.2~~ 2.3.2 Vegetation on the Lower Basin

The Lower Skagit River Basin has had many landscape alterations in the past. On the lower mainstem, these alterations have resulted in the riparian reserve system to be fragmented, poorly connected, and inadequate in its ability to provide protection for habitats and refugia for sensitive aquatic species such as salmon. In many areas below Sedro-Woolley, the establishment of dikes and levees has largely disconnected the river from its floodplain, reducing the once widely meandering river to a single, non-migratory channel. Floodplain habitats were significantly altered throughout the past 100 years through road building, bank hardening, hydropower operations, timber harvest in riparian zones and contributing upland areas, and rural development. The culmination of these alterations is seen in the reach spanning from the Skagit River Delta upstream 32 miles, where 62% of the mainstem channel edge has been hardened with riprap within about 200 feet of the channel's edge.

The Lower Skagit Basin currently encompasses a wide range of habitats which host an array of plant species. Western lowlands conifer-hardwood forest is widely distributed throughout the lowlands of the Cascades (Johnson and O'Neil 2001). This habitat is dominated by tree species such as Western hemlock and Douglas fir, with Western red cedar, Sitka spruce, red alder, and bigleaf maple also being common. This habitat also supports common understory plants such as salal (Gaultheria shallon), Oregon grape (Mahonia aquifolium), vine maple (Acer circinatum), Pacific rhododendron (Rhododendron macrophyllum), salmonberry, and trailing blackberry (Rubus ursinus) (Johnson and O'Neil, 2001). Wetland and riparian zones are present in this area and are dominated by black cottonwood, willows (Salix sp.), and red alder. Various areas of grassland range across many elevations throughout the basin. Species common to these habitats include Fescue sp., Poa sp., Carex sp., and Pinus sp. (Johnson and O'Neil 2001). Agriculture, pasture, and mixed environments are widely distributed at low to mid-elevations in the broad river valley. These areas include many cover types of cultivated croplands that include ornamentals, vegetables, grains, orchards, berries, and nurseries. Introduced species such as Himalayan blackberry (Rubus armeniacus), reed canary grass (Phalaris arundinacea), Scotch broom (Cytisus scoparius), Japanese knotweed (Polygonum cuspidatum), and butterfly bush (Buddleja davidii) are common throughout the lowlands.

Various measures of the health of the Lower Skagit River Basin have been used to assess its current status. A screening of the condition of riparian vegetation in floodplain habitats found significant impairment in most of the reaches surveyed (Beamer, et al. 2000). A majority of the present riparian zones below Sedro Woolley are either entirely devoid of trees or consist only of narrow strips of cottonwood and willow species. The reduced riparian area below Sedro-Woolley reduces the likelihood of recruitment of LWD to the stream system or providing essential pieces for stable log jam formations. Even without further disturbance, this condition is unlikely to improve significantly in the near future.

Limited examples of high quality riparian habitat are found in the lower reaches. For example, Cottonwood Island, a 170 acre parcel at the confluence of the North and South Fork, is representative of a historic habitat type (prior to logging and development) and provides valuable habitat for a variety of forest birds and raptors, primarily buteos and eagles (Garrett, et al. 2006). Assessment of LWD in the lower Skagit River indicates that there is a lack of large wood in the system (Collins 2000). While LWD is generated in large quantities in the Upper Skagit Basin, there are few areas in the Lower River where the LWD can become permanently or semi-permanently deposited in or along the bed and banks. There are some localized areas of low velocity, such as Freshwater Slough, where LWD collects.

~~2.8.3~~ 2.3.3 Wildlife of the Upper Basin

The Upper Skagit Basin and in particular, NCNP hosts one of the greatest diversity of wildlife in the United States. The National Park protection designated to this area has perpetuated its ecosystem allowing many wildlife species to thrive to this day. Many species of amphibians, reptiles, fish, birds, and mammals are all common in this area. Large mammals found in the Upper Skagit Basin include moose (Alces alces), elk (Cervus elaphus), black-tailed mule deer (Odocoileus hemionus), black bear (Ursus americanus), mountain lion (Puma concolor), coyote (Canis latrans), mountain goat (Oreamnos americanus), and wolverine (Gulo gulo). Federally listed ESA species; grizzly bear (Ursus arctos), gray wolf (Canis lupus), and Canada lynx (Lynx canadensis) are also known to inhabit the area (see “Threatened and Endangered Species” for more details). Other mammal species such as river otter (Lontra canadensis), American beaver (Castor canadensis), northern raccoon (Procyon lotor), American marten (Martes Americana), and American mink (Neovison vison) are also found in the Upper Skagit Basin. Common small mammals are Townsend's chipmunk (Tamias townsendii), trowbridge shrew (Sorex trowbridgii), deer mouse (Peromyscus maniculatus), snowshoe hare (Lepus americanus), Douglas squirrel (Tamiasciurus douglasii), and a variety of bat species.

Birds are a significant component of biological diversity within the Upper Skagit Basin ecosystem. Over 200 species in 38 families can be found in NCNP alone. Two species; marbled murrelet (Brachyramphus marmoratus) and northern spotted owl (Strix occidentalis caurina are ESA listed species (see “Threatened and Endangered Species” for more details). The rivers, lakes, and streams of the Upper Skagit Basin attract breeding, migrating, and wintering birds. Clear, fast-flowing rivers and streams in the area host breeding populations of Harlequin ducks (Histrionicus histrionicus). The Skagit River attracts one of the largest wintering concentrations of bald eagles (Haliaeetus leucocephalus) in the continental United States. In this region, the bald eagle wintering season spans from mid-December to late January. Each year, around 600 eagles are drawn to the area by the large numbers of spawned out salmon that are common to the Upper Skagit Basin (Skagit River Bald Eagle Awareness Team 2006). Though most of the area eagles are migrants, resident bald eagles do occur in the area. Nesting in the Upper Skagit Basin typically occurs between early January and mid-August.

Many species including raptors that breed further north migrate through this area in spring and fall. Over half of the species breeding in the Upper Skagit Basin are migratory. Hummingbirds, flycatchers, vireos, swallows, thrushes, warblers, tanagers, and grosbeaks are among the species that return annually in spring. From May through July species such as olive-sided flycatcher (Contopus cooperi), warbling vireo (Vireo gilvus), Swainson's thrush (Catharus ustulatus), Wilson's warbler (Wilsonia pusilla), and Western tanager (Piranga ludoviciana) all arrive to breed. In August and September, these species begin their migrations south. Federally listed marbled murrelets and Northern spotted owls also utilize the forests of the Upper Skagit Basin (see “Threatened and Endangered Species” for more details).

Various reptiles and amphibians reside in the Upper Skagit Basin. Common species include Western terrestrial garter snake (Thamnophis elegans elegans), common garter snake

(Thamnophis sirtalis), Northern alligator lizard (Elgaria coerulea), Cascade frog (Rana cascadae), Oregon spotted frog (Rana Pretiosa) (an ESA Candidate Species), Northern red-legged frog (Rana aurora), Pacific chorus frog (Pseudacris regilla), tailed frog (Ascaphus truei), Western toad (Bufo boreas), Northwestern salamander (Ambystoma gracile), and Northern rough-skinned newt (Taricha granulosa).

Climate change may lead to a much altered wildlife species assemblage found in the Upper Skagit Basin. Changes seen in vegetation communities due to changes in precipitation, temperature, pest and forest fire regimes will affect wildlife demographics. For example, warming streams could decrease already declining anadromous fish stocks and amphibians found in the area.

~~2.8.4~~ 2.3.4 Wildlife of the Lower Basin

The Skagit River Delta area is considered critical wildlife habitat for many species. It is particularly important as a waterfowl wintering area due to the mild winter climate and the presence of habitats such as expansive freshwater marshes, saltwater marshes, and intertidal flats. The many dikes or levees along its numerous sloughs have created extensive upland areas for agriculture. Various grain crops produced in areas such as Skagit Wildlife Recreation Area between Tom Moore Slough, Freshwater Slough, and the Hayton Reserve, are known to support waterfowl and other wildlife.

Few winter residents breed in the project area (in spring most leave for breeding areas further north). Wintering waterfowl common along the area sloughs in Skagit Bay and upland on farms during the peak months of October and November include ducks, geese, and swans. Dabbling ducks, such as mallard (Anas platyrhynchos), Northern pintail (Anas acuta), American widgeon (Anas americana), and green-winged teal (Anas crecca) are the most numerous, and utilize estuarine and agricultural areas. Snow geese (Chen caerulescens) are also present in the fall and winter months in the Skagit Delta. In past years, up to 50,000 have wintered in Skagit Flats. Swans (mainly trumpeters, but also more than a thousand tundra swans) visit the Skagit Estuary, feeding mainly on vegetation in shallows and agricultural fields. The trumpeter swan (Cygnus buccinators), once an endangered species, has increased in numbers in Skagit County from a 1963 population of 20 to several thousand today. The major wintering roosting area for this species is the Nookachamps Creek drainage (DeBays Slough and Judy Reservoir). Freshwater riparian habitat is important for waterfowl. The numerous sloughs adjacent to Skagit Bay are highly productive for mallards and wood ducks (Aix sponsa). Tom Moore Slough, near Milltown, provides productive habitat for waterfowl.

Wading birds, such as great blue heron (Ardea herodias), utilize the estuary areas year round. Shorebirds use flooded agricultural fields and estuaries mainly during migration and in winter. Mainly dunlin (Calidris alpine) and black-bellied plover (Pluvialis squatarola) winter in the Skagit delta. Several species of birds of prey are found in the project area including bald eagle (Halieaeetus leucocephalus), red-tailed hawk (Buteo jamaicensis), rough-legged hawk (winter only) (Buteo lagopus), Northern harrier (Circus cyaneus), gyrfalcon (winter only) (Falco rusticolus), peregrine falcon (Falco peregrinus), merlin (Falco columbarius), Coopers hawk (Accipiter cooperii), sharp-shinned hawk (Accipiter striatus), and osprey (Pandion haliaetus). The Skagit Delta provides habitat for one of the largest wintering populations of raptors in the contiguous United States. Bald eagles are also common in the Lower Skagit Basin along the Skagit River and its tributaries.

Large upland mammals, such as black-tailed mule deer, can be found on Hart Island and are occasional visitors to the estuary, although this type of habitat is not favored by this species. The abundance of small mammals in the Skagit Delta accounts for the presence of raptors in the area. Semi aquatic mammals such as muskrat (Ondatra zibethicus), river otter, mink, and beaver inhabit the sloughs. In addition, nutria (Myocaster coypus), a large, destructive, semi-aquatic, non-native rodent have been confirmed to be present in the Skagit Valley. Nutria cause severe damage to native wildlife habitat and dikes due to their indiscriminate consumption of vegetation and burrowing techniques.

~~2.8.5~~ 2.3.5 Fish

Anadromous species, which are common to the Skagit River, tend to move through both the Lower and Upper Skagit Basin en route to spawn. Because these fish can be found in either basin, they will be discussed in a single section that includes both of these areas. Fish that are only found in one subbasin will also be discussed below.

Most of the historic estuarine habitat was lost after diking isolated these areas from riverine and tidal processes. Further upstream, the waters of the Skagit River became degraded by runoff from the extensive logging operations in the headwaters. The installation of dams along the length of the Skagit further degraded the ecosystem.

Many beaver ponds, side channels, and sloughs once used by salmon have been disconnected from the main river channel as a result of diking and other agricultural practices and bank revetments. From 1860 to 1951, side channel slough habitat decreased by approximately 90% in the Skagit delta (Collins 2000). The Skagit basin lost approximately 45% of the historic side channel habitat (424,200 m2) that provided critical rearing and refuge functions in the floodplain (Beechie, et al. 1994). The Skagit basin has lost approximately 72% of historic estuarine delta habitat, including a loss of 68% of estuarine emergent habitat, 66% of transitional estuarine forested habitat, and 84% of riverine tidal habitat (Beamer, et al. 2002a; Collins and Montgomery 2001). The Skagit delta has lost approximately 75% of its distributary channel habitat (Beechie, et al. 2001). A reduction in the number of side channels and sloughs, changes and reductions in the quality of riparian vegetation, and a reduction in the number of high quality stream channel pools significantly reduces the amount of available refugia resulting in not properly functioning conditions.

The Skagit River and the Skagit Estuary are critically important to all five species of Pacific salmon as well as steelhead and sea-run cutthroat. There are numerous runs that utilize both the mainstem Skagit and several of its tributaries, most of which spawn in the reaches above Sedro-Woolley. The Skagit River and its tributaries also host the largest population of Puget Sound bull trout in Puget Sound Basin (Conner, Seattle City Light, pers. comm.). The lower reaches of the Skagit River serves as a transportation route for spawning adults and provides a rearing environment for juvenile anadromous species during their outmigration to the sea. The upper reaches of the Skagit River from Sedro-Woolley up to Gorges dam, the Sauk River, the Cascade River, Lake Shannon and Baker Lake along with other upper tributaries compromise the majority of the spawning habitat. In these more natural upper sections of the river, suitable habitat features are still available for spawning and rearing, however the historic loss of tidal wetland and channel habitat from the Lower Basin has been identified as one of the most significant limiting factors in the recovery of Skagit Chinook (SWC 2005; WCC 2003). Research by the Skagit River System Cooperative and others has shown that the reduced amount of estuarine habitat is likely limiting the production of Chinook (Beamer, et al. 2003; Beamer, et al. 2002; Beamer, et al. 2000; Congleton, et al. 1981). Less than 27% of estuarine habitat remains (SWC 2004; WCC 2003), with the greatest losses occurring in riverine tidal habitat (less than 16% remains). Most of the historic estuarine habitat was lost after diking isolated these areas from natural occurring riverine and tidal processes.

In 1992, seven populations of steelhead were described in the Skagit Basin; four populations of winter steelhead and three populations of summer steelhead; all are listed as being of native origin and with wild production. The winter steelhead population declined from a healthy status in the 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI), to a depressed status in the 2003 Washington State Salmonid Stock Inventory (SaSI) (WDFW and WWTIT 2003).

Very little spawning occurs in the lower reaches of the Skagit River, although documented Chinook, pink, and mainstem steelhead spawning areas fall within the lower portions of the watershed (WDFW 2003). Coho spawning also occurs in the Carpenter and Fisher Creek drainages and in Nookachamps Creek. In the more natural upper sections of the River, suitable habitat features are available for spawning and rearing. Seiler, et al. (1999) found that egg-to-migrant survival rates were highly correlated to flow.

With effects from climate change becoming more apparent (see the discussion on climate), it is thought that future pressures on salmonids in the Skagit Basin will be severe. Skagit River salmonids have already experienced a variety of pressures caused by many changes such as; diking, insufficient riparian vegetation and LWD, and floodplain development. The combination of these existing pressures and warmer wetter winters and hotter dryer summers could combine and lead to elevated summer and early fall water temperatures due to a lack of snow and glacial melt. Evidence suggests increased water temperatures may be intolerable to salmonids. Bull trout populations in the Skagit River system would be particularly affected since they require water no warmer than 9°C for spawning and no warmer than 12°C for rearing.

Predicted sea level rise would cause the freshwater and brackish marshes to retreat landward due to saltwater intrusion, forcing these marshes into an area already reduced by extensive development that has already occurred in the floodplain. This further reduction of brackish habitat that is required for smoltification and acclimation to changes in salinity, is estimated to range from a 77% to 97% total loss (Glick, et.al. 2007), further limiting the production of anadromous fish in the Skagit Basin.

Several resident fish species are also found in the Skagit River system. While these species are all found in the Lower Skagit Basin, some can be also found in the Upper Basin. These species include rainbow trout (Oncorhynchus mykiss), kokanee (Oncorhynchus nerka), mountain whitefish (Prosopium williamsoni), Salish sucker (Catostomus catostomus), largescale sucker (Catostomus macrocheilus), three-spine stickleback (Gasterosteus aculeatus), brown trout (Salmo trutta), brook tout (Salvelinus fontinalis), lake trout (Salvelinus namaycush), Western brook lamprey (Lampetra richardsoni), Pacific lamprey (Lampetra tridentata), torrent sculpin (Cottus rhotheus), prickly sculpin (Cottus asper), and coast range sculpin (Cottus aleuticus).

~~2.8.6~~ 2.3.6 Threatened and Endangered Species

Several federally listed threatened and endangered species occur in both the Lower and Upper Skagit Basins. Because most of these species occur in both basins, each species will be discussed in its own section.

Table 2.1 - Species Potentially Occurring in the Project Area

SPECIES	SCIENTIFIC NAME	STATUS
Puget Sound Chinook Salmon	*Oncorhynchus tshawytscha*	Threatened
Puget Sound/Strait of Georgia Coho Salmon	*Oncorhynchus kisutch*	Candidate
Puget Sound Steelhead	*Oncorhynchus mykiss*	Threatened
Coastal/Puget Sound Bull Trout	*Salvelinus confluentus*	Threatened

Marbled Murrelet	*Brachyramphus marmoratus*	Threatened
Northern Spotted Owl	*Strix occidentalis*	Threatened
Grizzly Bear	*Ursus arctos*	Threatened
Canada Lynx	*Lynx canadensis*	Threatened
Gray Wolf	*Canis lupus*	Threatened

(WDFW 2008)

Puget Sound Chinook Salmon - Six stocks of Puget Sound Chinook salmon occur in the Upper Skagit with most being ocean type. The lower Skagit Chinook population was classified as depressed in both the 1992 SaSI and the 2003 SaSI (WDFW and WWTIT 2003). Spawning occurs from early September to mid-November (WDFW and WWTIT, 2003) in the Upper Skagit Basin. Lower Skagit Chinook spawn in the mainstem Skagit River and in tributaries downstream of the Sauk River confluence; most of the spawning occurs in the mainstem Skagit River between Sedro Woolley and the Sauk River (WDFW and WWTIT 2003). Upper Skagit Chinook spawn from mid-August through October in the mainstem Skagit River and in tributaries upstream of the Sauk confluence. The lower Sauk Chinook population spawns in the Sauk River from the mouth upstream to the Darrington Bridge at river mile 21.2. Its status was classified as depressed in both the 1992 and 2003 population inventories (WDFW and WWTIT,2003). The Lower Sauk population spawns earlier, beginning in late August and continuing to early October, than the mainstem Skagit populations. Upper Sauk Chinook spawn upstream of the Darrington Bridge and into the North and South Forks of the Sauk River. The status changed from healthy in 1992, to depressed in 2003 (WDFW and WWTIT 2003). Spawning occurs from late July through early September. Suiattle Chinook have the same early spawn timing as upper Sauk Chinook. The Suiattle population spawns in the mainstem Suiattle River, and in Big, Tenas, Straight, Circle, Buck, Lime, Downey, Sulphur, and Milk Creeks. Its population status changed from depressed in 1992, to healthy in 2003. Upper Cascade Chinook spawn in the mainstem Cascade River above RM 7.8, in the lower reaches of the North and South Forks of the Cascade River, and in Marble, Found, Kindy, and Sonny Boy Creeks. Its population status changed from unknown in 1992, to depressed in 2003. Spawning occurs from late July through early September.

Critical habitat has been designated for the entire Lower Skagit and Upper Skagit River. Critical habitat primary constituent elements (PCEs) include freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors. Additional PCEs were developed for estuarine and marine habitats.

Coastal/Puget Sound Bull Trout - The Skagit River supports the largest natural population of bull trout/Dolly Varden in Puget Sound. Of this population, Lower Skagit bull trout were identified as a distinct stock based on their geographic location; an area which includes all of the Skagit River and its tributaries located below the Gorge Dam, excluding the Baker River (WDFW 1998). Anadromous, fluvial, adfluvial, and resident life history forms are all found in the Skagit River system, at times spawning at the same time and place. Spawning usually takes place during October and November, and occurs in upriver areas that are less than 8°C (WDFW 1998). Bull trout are apex predators that locate where prey is abundant and will follow prey such as migrating juvenile salmon.

Based on sampling by the Skagit River System Cooperative (Beamer and Henderson, 2004), bull trout were found to use delta blind tidal channels but did not directly use smaller and shallower channels or channels more distant from river distributaries. Trends in annual abundance remained constant during the study. The presence of bull trout varies significantly throughout the year, with the primary period from April through August, with a peak in June. Bull trout in the Skagit are known to migrate to both Puget Sound and other river systems including the Stillaguamish and Snohomish, in search of food. Although the majority of these migrants return to the Skagit to spawn (Geotz, per. comm. 2008).

Bull trout are also present in Skagit Bay; however, their presence in shallow intertidal habitat was very low compared to the deeper intertidal-subtidal fringe. Bull trout are present in the deeper intertidalsubtidal habitats year round. Peak abundance in the bay occurs in May or June, with recent data showing a second peak in fall.

Critical habitat was designated for the entire Lower Skagit and Upper Skagit River to the portions of Ross Lake and its tributaries that lie within the boundaries of the United States. Critical habitat PCEs determined essential to the conservation of bull trout include water temperatures between 36°F and 59°F, complex stream channels, appropriate substrate for spawning and rearing success, a natural hydrograph, sufficient water quality and quantity including subsurface connectivity, migratory corridors, abundant food base, and lack of nonnative predatory or competitive species.

Puget Sound Steelhead - All seven stocks of Skagit River steelhead are found in both the Upper and Lower Skagit Basins. All are listed as being of native origin and with wild production and are considered to be distinct based on geographic separation. Steelhead in the Skagit River system spawn in both the mainstem and tributaries from the anadromous zones to the headwaters. Summer steelhead run through the Skagit system from May to October and winter steelhead run from November to April. Although there is some fishing pressure on wild steelhead in the Skagit River system, the majority of fishing is for hatchery fish that are planted in the river annually. Of the seven wild stocks of steelhead in the Skagit system five of them have an unknown stock status. The remaining stocks; winter run of the mainstem Skagit River and Samish winter run have stock statuses of healthy and depressed, respectively (WWTIT 2003). Critical habitat has not yet been designated for Puget Sound Steelhead though it is pending.

Skagit mainstem winter steelhead spawning takes place in the mainstem Skagit from just above Mount Vernon up to Gorge Dam and all the major tributaries in between including the Nookachamps, Sauk and Cascade Rivers, and Lake Shannon and Baker Lake. Spawning occurs from early March to early June. Mainstem Skagit winter steelhead stock status has gone from healthy in 1992 to depressed in 2002 (WDFW 1994; WDFW 2003). Finney Creek summer steelhead are thought to spawn in Finney Creek up to the falls at river mile 11.7, however, precise locations are unknown. Spawn timing and stock status are also unknown. Sauk summer run steelhead spawn in the North Fork and South Fork of the Sauk River to just below the forks. Spawning occurs from mid-April to early June, and stock status in unknown. Sauk winter run steelhead spawning takes place in the Sauk, Suiattle, and Whitechuck rivers and their tributaries. Cascade ? summer run spawn time occurs from mid-March to mid-July and the stock status is unknown. Cascade summer run steelhead spawning is thought to take place in the upper reaches of the Cascade river and its forks, however exact locations are unknown. Spawning occurs from mid-January to early May, and stock status is unknown. Cascade winter run steelhead spawning locations are unknown, as is the spawning time (although it is thought to occur in early March through late June.

Puget Sound/Strait of Georgia Coho Salmon - Puget Sound/Strait of Georgia coho evolutionary significant unit (ESU) includes coho that spawn throughout the Skagit system in smaller tributaries with good cover. Spawning typically occurs from October through late February. Juveniles rear for approximately one year in slower water habitats before out-migrating in the spring and early summer of their second year (WDFW, 1994).

Marbled Murrelet - Murrelets inhabit shallow marine waters and nest in mature old-growth forests. Critical habitat has been designated to include upland forested stands containing large trees (greater than 32 inches) in diameter with potential platforms for nesting (greater than 33 feet) and the surrounding forested areas within 0.5 mile of these stands with a canopy height of at least 1/2 the site-potential height (USFWS 1996). All nest locations in Washington have been located in old-growth trees that were greater than 32 inches in diameter at breast height (dbh) (Ralph, et al. 1995). Nest stand characteristics generally include a second story of the forest canopy that reaches or exceeds the height of the nest limb, thereby providing a protective enclosure surrounding the nest site. A single, large, closed-crowned tree, which provides its own protective cover over the nest site may also be used by murrelets (Ralph, et al. 1995). Large, moss-covered limbs (greater than 7 inches diameter) in tall trees are utilized for egg-laying. Marbled murrelet nests have been located in stands as small as approximately seven acres (Hamer and Nelson 1995) and are generally within 50 miles of marine waters. In Washington, marbled murrelet abundance was found to be highest in areas where old-growth/mature forest comprised more than 30 percent of the landscape. Murrelet nesting habitat is characteristic of the forested mountain landscape in the upper Skagit basin.

Critical habitat for the marbled murrelet has been designated throughout the Upper Skagit basin (USFWS, 2006). US Forest Service surveys indicate that the northern half of the Mount Baker-Snoqualmie National Forest accounts for 50 percent of the nesting habitat and 85 percent of the detections in the entire forest (USFS 2002). Numerous confirmed occurrences of marbled murrelets have occurred over the past two decades in both Whatcom and Skagit counties (WDFW 2008).

Northern Spotted Owl - Spotted owls can be found throughout the west slope of the Washington Cascades below elevations of 4,200 feet. Preferred owl habitat is composed of closed-canopy coniferous forests with multi-layered, multi-species canopies dominated by mature and/or old-growth trees (USFWS 2008). Habitat characteristics include moderate to high canopy closure (60-80%); large (greater than 30-inch dbh) overstory trees; substantial amounts of standing snags, in-stand decadence, and coarse woody debris of various sizes and decay classes scattered on the forest floor (Gore, et al. 1987; Thomas, et al. 1990). Critical habitat is characterized as large continuous blocks of coniferous/mixed-hardwood forests that contained one or more of the primary constituent elements (primarily nesting and roosting, but also foraging and dispersal). It is usually equivalent to structures of Douglas fir stands 80 or more years of age (USFWS 1992).

Designated critical habitat for the northern spotted owl is found throughout the upper Skagit basin. Numerous confirmed occurrences of the spotted owl over the past two decades are documented in both Whatcom and Skagit counties (WDFW, 2008).

Grizzly Bear - Estimates according to Ingles (1974), there were approximately 10 grizzlies in Washington State with these few remaining in remote areas of the North Cascades. WDFW priority habitat lists both Whatcom and Skagit (both of which encompass the upper Skagit basin) along with all their neighboring habitats as potential grizzly bear habitat (WDFW 2008). Recent estimates of grizzly bear population in the North Cascades range from 12 to 50 individuals (Almack, et. al., 1993; MacCracken and O'Laughlin 1998). According to the National Park Service approximately 10 - 20 grizzly bears live within Washington's North Cascades Grizzly Bear Recovery Area, roughly defined as the area between Interstate 90 in the south, up the Columbia and Okanogan Rivers on the east to the international boundary; then back south generally along the Mount Baker-Snoqualmie National Forest's western boundary (which is the western portion of both Skagit and Whatcom counties beginning just east of the towns of Lyman and Glacier). All five of the major dams on the Skagit River system fall within this recovery area. In British Columbia's North Cascades Grizzly Bear Population Unit (bounded by the Trans-Canada Highway, Highways 8, 5A and 3 and the international border), the minimum population estimate is 17 grizzly bears (NPS 2008). However, it is difficult to get exact estimates of grizzly bears as their territories can be several hundred square miles and their behavior is secretive. A study using DNA analysis of fur snags via barbed wire and scent lures showed only one grizzly present at the snag sites over the course of three years in the North Cascades and suggested that natural recovery seemed unlikely (Romain-Bondi, et.al. 2004).

Grizzly bear sightings in the North Cascades Ecosystem are classified as categories 1-4, with class 1 being the most reliable (verified by a biologist, photograph, and/or carcass) and 4 being the least (a sighting initially reported as a grizzly but later confirmed to be another species).

Between 1983 and 1991, there were 20 Class 1 sightings, 82 Class 2 sightings, and 102 Class 3 sightings. In 1996, a bear biologist saw a grizzly bear on the south side of Glacier Peak in the Glacier Peak Wilderness Area. This is the last recorded Class 1 observation (Grizzly Bear Outreach Project 2008). According to the WDFW priority habitat database confirmed grizzly bear occurrences have been reported numerous times around Ross Lake in the 1970’s, 80’s, and 90’s. They have also been occurrences at Diablo Dam in 1983, 1987, 1992, and 1993. The database also reports single confirmed occurrences near the North Fork Sauk River, the Cascade River, Bacon Creek west of Baker Lake, and Ruby Creek near the Okanogan County border (WDFW 2008).

Gray Wolf - According to Ingles (1974), the gray wolf is present in a small area in the North Cascades, although rare, and in hard, cold winters they may come down to lower elevations for food. The northern part of the Upper Skagit Basin falls within this distribution. WDFW also confirms the presence of wolves in the North Cascades. They are regularly sighted in southern British Columbia just north of North Cascades National Park. WDFW lists both Whatcom and Skagit County (both of which encompass the Upper Skagit watershed) along with all their neighboring counties as priority habitat for wolves (WDFW 2008). The data base indicates many occurrences of gray wolves over the last two decades, many of which were within close proximity of Ross Lake. In 1991, wolves with pups were observed near Hozomeen at the north end of Ross Lake. Other confirmed occurrences in the watershed include Baker Lake in 1984 and 1992, the Sauk River in 1992, Suiattle River in 1989, and the mainstem Skagit near Briar and Copper Creeks in 1988 and 1992, respectively (WDFW 2008). Locations of other sightings in the North Cascades include McAlester Pass, Pasayten Wilderness and Twisp River drainage of the Okanogan National Forest, Glacier Peak Wilderness, and Stevens Pass (NPS 2008b). A more recent sighting of a grey wolf pair and pups, and howling surveys in July of 2008 have verified their presence in western Okanogon County just adjacent to Skagit and Whatcom counties (WDFW 2008).

Canada Lynx - Canada lynx require dry forests where lodgepole pine is the dominant tree species. These areas are more typical of the east slopes of the Cascades. Lynx are rarely found below elevations of 4,000 feet. In 2001, the population of Canada lynx in Washington State was estimated at fewer than 100 individuals (Stinson 2001). A small population of Canada lynx inhabits the Pasayten Wilderness east of Ross Lake in the Okanogan National Forest (NPS, 2007). Canada lynx are not known or suspected in the Upper Cascade watershed (Stinson 2001). Critical habitat for Cananda lynx has been designated on the eastern slopes of the Cascades in Okanogon County- just east of Skagit and Whatcom counties (USFWS, 2008). However, the WDFW priority habitat and species list includes both Whatcom and Skagit counties as priority habitat for Canada lynx and there are several confirmed occurences most of which are along the easternmost portions of the two counties along the Okanogon County border. In 2000 there were confirmed Canada lynx occurrences on the west slopes of the Cascades near Devils Dome and Buckskin Ridge just four miles and seven miles east of Ross

Lake, respectively (WDFW 2008). Numerous anecdotal reports of Canada lynx have occurred around Baker Lake and Mount Baker (USFWS 2001).

~~2.8.7~~ 2.3.7 Wetlands and Other Waters of the United States

A wetland survey of the delta conducted by Shapiro and Associates for the Corps of Engineers in 1978 identified 3,450 acres of estuarine wetland, 120 acres of riverine wetland, and 3,150 acres of palustrine wetlands adjacent to the Skagit River in the delta. This study did not attempt to identify wetlands that were converted to agricultural uses.

Prior to 1879, a log jam nearly one mile in length came close to covering the entire river near the location of Mt. Vernon. During freshets, this jam obstructed the free flow of water and obstructed the passage of all logs and drift. This blockage prevented the free flow of flood waters, thus reducing flooding in the delta area. Consequently, flooding primarily occurred in the areas known as Olympia and Beaver Marsh, located to the west of the Skagit River between the present locations of the town of Avon and Padilla Bay (Corps 1897).

In 1881, Robert Habersham, an Assistant Engineer for the Corps, wrote that while making an examination of the lowlands lying between the Skagit and Samish Rivers in 1872, he saw indications that the Skagit flowed into Padilla Bay at one time, 12 miles north of the present mouth of Steamboat Slough. The old channel was easily traced, traversed by numerous beaver dams. Habersham felt that the beaver dams caused the channel to change (Corps 1881). In 1924, the U.S. Geological Service (USGS) confirmed this observation concluding that Padilla Bay was once the mouth of the Skagit River. When the channel changed, the old outlet was filled with alluvial mud (C.H., personal communication). (USACE, 2009)

National Wetland Inventory maps have identified pockets of wetland areas on both sides of the dikes in the Skagit delta. Despite this, the majority of the lowlands in the delta exhibit wetland characteristics. In most cases, the intensive agricultural practices on the land have caused these lands to be effectively drained and thus they can be designated as prior converted cropland (Kilcoyne, per. comm. 2006). Based on an inventory conducted in 1991, it is thought that there are approximately 76,188 acres of potential wetlands (land that could be wetland but has not been directly delineated) in Skagit County. Approximately 41% of this acreage is currently estuarine or marine wetland habitat. (USACE, 2009)

A large expanse (~2,500 acres) of vegetated wetlands is present beyond the sea dikes at Fir Island (Shapiro, 1978). Beyond this marsh are approximately 6,600 acres of eelgrass beds (G. Hood, pers. comm., Skagit River System Cooperative 2008) and approximately 10,000 acres of unvegetated intertidal flats. Padilla Bay lies to the north of the project area. In historic times, floodwaters from the Skagit reached Padilla Bay on a regular basis; however, dikes constructed along the river now prevent Skagit River flows from reaching the bay. This change results in sedentary conditions being present within the bay, increasing the size of eelgrass beds. Padilla

Bay now has approximately 8,000 acres of eelgrass, making it one of the largest eelgrass concentrations on the west coast of North America.

Sea level rise will likely shift the distribution of eelgrass beds, mudflats, and salt, brackish, and freshwater marshes landward. This shift will be restricted on the landward side due to the development that abuts the marshes leading to a likely overall decline in brackish and freshwater habitat. Most of the brackish marsh in Skagit Bay that is present today would be converted to salt marsh (Glick, et.al. 2007). It is speculated that eelgrass beds may benefit due to an increase in shallow saltwater habitat (G. Hood, per. comm., Skagit River System Cooperative 2008).

Climate change, and the associated changes in precipitation and groundwater patterns, may result in large scale changes to wetland complexes and the functions they provide. Increased intensity of flood events may alter the sedimentation deposition and erosion patterns. Changes in precipitation patterns may alter groundwater recharge/discharge rates and locations, and reduced summer river flow may alter the vegetation communities and animal habitats in these wetlands. (Kusler 2005). (USACE, 2009)

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