Chapter 2 - Skagit River Basin Characteristics

2.0 Overview

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).

2.2 Topography

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 Geology

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 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. (NRCS, 2006)

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. (NRCS, 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)

2.5 Climate

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)

2.6 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 1950. Diablo Dam was completed in 1931, 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). The Skagit Valley, the 100,000-acre, 54-mile-long valley between Concrete and the river mouths, contains the largest residential and farming developments in the basin. It is made up of cattle and dairy pastureland, agricultural areas, the urban areas of Sedro-Woolley, Mount Vernon, Burlington and La Conner (all located in the flood plain), and wooded areas. West of Sedro-Woolley, a large alluvial fan floodplain (east-west width of about 1 1 miles and a north-south width of about l9 miles) had its origin about 5,900 years ago from a series of lahars (or a single event) originating from Glacier Peak (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 Environmental & Biological Resources

2.81 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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

2.82 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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

2.83 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. (USACE, 2009)

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. (USACE, 2009)

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). (USACE, 2009)
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). (USACE, 2009)

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. (USACE, 2009)

2.84 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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

2.85 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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

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). (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

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). (USACE, 2009)

2.86 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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

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 September and October, 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. (USACE, 2009)

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). (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

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. (USACE, 2009)

Skagit mainstem winter steelhead spawning takes place in the mainstem Skagit from just above Mount Vernon up to Gorges 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 takes place in the Sauk, Suiattle, and Whitechuck rivers and their tributaries. Spawn time occurs from mid-March to mid-July and the stock status in 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. (USACE, 2009)

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 and USACE, 2009)

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. (USACE, 2009)

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 (National Park Service 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).

2.87 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. (USACE, 2009)

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. (USACE, 2009)

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 (Greg 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).

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