Chapter 3. Affected Environment

This chapter describes the environment that may be affected by land acquisition and management activities of Nisqually NWR. The affected environment includes important portions of the Nisqually delta and lower reaches of the Nisqually River watershed. For this document, the affected environment includes the CCP Study Area, which includes the lands within the currently approved Refuge boundary (3,936 acres) and the potential Refuge expansion areas (5,390 acres). The study area (Figure 1.1-2) includes four distinct areas: McAllister Springs and Creek area, Nisqually River corridor, Nisqually agricultural lands and floodplain, and East Bluff. The McAllister Springs and Creek area, Nisqually River corridor, and Nisqually agricultural lands and floodplain are located south of the current Refuge and are bordered on the north by I-5, on the east and west by bluffs, and on the south by a combination of railroad tracks, bluffs, and property boundaries of residential housing developments. The East Bluff area is east of the Refuge and is bordered on the north by Sequalitchew Creek, on the west by Puget Sound, on the south by I-5, and the eastern boundary follows property lines, including most of the forested habitat west of Fort Lewis.

3.1 Physical Environment

Elements of the physical environment considered include climate, hydrology, geology, soils, and contaminants.

3.1.1 Climate

Maritime air masses have a moderating effect in south Puget Sound year round, creating a modified Mediterranean climate. Air quality is generally high due to climate, location, and few industries that produce particulates. Average annual rainfall is 53 inches in nearby Olympia. During the fall and spring seasons, the climate of the Nisqually delta is relatively mild. Winters are usually wet and mild, with intermittent moderate to heavy rain rather than snow. Summers are generally cool and dry.

The Olympic coast and Cascade ranges protect south Puget Sound from strong south-southwest prevailing winds associated with winter storms. Average fall and winter daytime temperatures range from 40°F to the low 50s. Winds are northeasterly during the summer and fair-weather periods. July, August, and September temperatures average 60 to 70°F, exceeding 90°F on approximately six days each summer. The average growing season is 250 days, depending on elevation and distance from Puget Sound (D. Weaver, pers. comm.; USFWS 1978; Thurston County Advance Planning and Historical Preservation 1994).

3.1.2 Hydrology

3.1.2.1 Freshwater

Freshwater sources on the CCP Study Area include the Nisqually River, McAllister and Red Salmon creeks, Medicine Creek, McAllister Springs, and groundwater aquifers and artesian

wells. Surface drainage primarily enters the delta from the Nisqually River, McAllister Creek, and Red Salmon Creek (USFWS 1978). A subsurface aquifer is located 175 feet below the delta (USFWS 1977, 1978).

Originating on the south slope of Mount Rainier, the Nisqually River is 78 miles long and has a 712 square mile drainage basin. Flow volumes in the upper half of the Nisqually River result from runoff and snow melt into the tributaries (Canning 1986). Located at river mile 44.2 and 42.5 are Tacoma City Light's Alder and LaGrande hydroelectric dams, respectively. These dams and their reservoirs have altered the natural flow regime by regulating downstream discharge (Whiley and Walter 1998). From the town of Yelm to the delta, the floodplain width broadens to 1 mile, bordered by bluffs on both sides rising 200 feet. Peak flows on the Nisqually River occur during winter (December through February) and late spring (May and June). Low flow periods occur in August and September. Low flows of about 1,000 cubic feet per second (cfs) usually occur in June through October in the watershed; wet season flow values are typically around 2,000 cfs (ENSR 1999). Flood flows of about 13,000 cfs were recorded in December 1995. River discharges over 18,000 cfs can overflow onto the riverbanks (Consoer et al. 1974; USFWS 1977).

McAllister Creek originates at McAllister Springs in the lower Nisqually River Valley at 6.7 feet above mean sea level. Numerous small springs and seeps also feed into the creek near its headwaters (Thurston County Department of Water and Waste Management 1993). McAllister Springs is the source for the municipal water supply for the City of Olympia (Consoer et al. 1974). A wellhead protection plan was developed and implemented in 1995 to decrease the possibility of contamination of the drinking water supply and to provide reaction time for a town to find another water source or install a treatment system in the event of water contamination (City of Olympia 1995).

McAllister Creek flows north through the study area and Refuge for 6 miles to the Nisqually Reach in Puget Sound. A very low stream gradient allows the tide to influence the creek all the way to its source, and creek salinity varies with the tide. The streambed changes to sand, peat, and muck downstream toward the delta. Medicine Creek is the longest tributary to McAllister Creek, originating near the Nisqually River and flowing 3½ miles, joining McAllister Creek at river mile 4.1. Another tributary to McAllister Creek is Little McAllister Creek. In wetlands above McAllister bluff, Little McAllister Creek travels through a steep ravine into agricultural ditches that outfall into McAllister Creek (Thurston County Dept. of Water and Waste Management 1993).

Red Salmon Creek originates in the eastern uplands above the delta as a shallow gradient creek that courses through marshes to the east delta bluffs, where it enters the Nisqually River (USFWS 1978).

Groundwater aquifers and several artesian wells are located within the study area. Generally, groundwater flows toward Puget Sound and major drainages, but patterns can vary locally. Groundwater of the Nisqually River watershed occurs mostly in the glacially deposited unconsolidated sand and gravel aquifers. Infiltrated precipitation recharges the central and western portions of the watershed (Emmett 1995). A 500 square mile south-central Pierce County aquifer extends north and east to the Puyallup River and Ohop Creek, bordering the

Nisqually River and Puget Sound to the south and west. The U.S. Environmental Protection Agency (EPA) has designated this aquifer as a sole source aquifer and is a primary drinking source for Pierce County (Emmett 1995; Moulton 1994; White 1997).

Population growth in the watershed is increasing the demand for water. Currently, 225,000 people live in the watershed, with 169,000 using the Pierce County aquifer as their sole source for drinking water (which supplies on the average of 42 million gallons of drinking water per day) (Emmett 1995). The City of Olympia withdraws 7 to 15 million gallons of water per day from McAllister Springs to serve approximately 40,000 customers (V. Decillo, pers. comm.). Groundwater withdrawals within all the drainages have the potential to adversely affect critical flows (Emmett 1995).

3.1.2.2 Estuary

The Nisqually River provides the majority of the freshwater to the estuary. The tidally driven reach currents distribute the turbid plume of river waters and sediment into a crescent-shaped pattern across the delta front (Thom et al. 1985). McAllister Creek also opens into a broad, tidally influenced estuary with a silt and muck streambed, braided distributaries, and mudflats at Nisqually Reach (Thurston County Dept. of Water and Waste Management 1993).

The delta undergoes two daily high and low tides. The mean higher high water (MHHW) line in the Nisqually Reach is 13.5 feet, and the maximum yearly tide is 18.7 feet (J.G. Dunbar, pers. comm.). Tidal influence extends upstream of the Nisqually River to about river mile 3.3 (Canning 1986). Very low tidal cycles (below Mean Low Low Water [MLLW]) usually occur twice a month, and the lowest tides occur during the spring and summer (-3.5 feet MLLW) (Wisseman et al. 1978).

3.1.3 Geology

The Nisqually delta is one of several river-mouth estuaries within the greater fjord-type estuary of Puget Sound. The delta is located in the Puget Trough, a broad structural and topographic depression formed at the time of the final uplift of the Cascade and Coast Range mountains, 11 million years ago (Burg 1984). Areas of volcanic activity raised large volcanic cones such as Rainier and Baker. Sedimentation, glaciation, and pressure between plates all worked to form the Puget Sound lowlands (White 1997).

After erosion, deposition, and plate tectonics worked on the landscape in Puget Sound for approximately 60 million years, a series of glaciers advanced from what is now British Columbia into the lowlands between the Cascade and Olympic ranges (White 1997). After each advance, the glaciers receded to the north and up the valleys to higher elevations, where they persist today. Between 150,000 and 15,000 years ago, these glaciers formed a glacial drift plain of gravels, sand, silt, clays, and tills that comprise the gently undulating surface of the Puget Sound lowlands (White 1997). When the last glacier receded about 14,000 years ago, the valleys were flooded with sea water and became the major basins and numerous smaller inlets of Puget Sound (Burg 1984). In lowland areas around the sound, retreating glaciers left behind a thick mantle of lacustrine and outwash sediments over the bedrock as far south as Chehalis, Washington (Burg

1984). The Nisqually River carved a deep valley into its floodplain, building the present-day delta when sea level reached its present condition 5,000 years ago. Sediments deposited at the mouth of the river built the delta northward a distance of at least 2.4 km until an equilibrium was reached between the river's deposition and tidal current erosion in the Nisqually Reach. The delta achieved its unique crescent shape during the final stages of development when more extensive outward growth occurred along the east and west margins where tidal currents were weaker (Burg 1984).

3.1.4 Soils

Refuge soils vary widely, from the hydric soils of tidal marshes to the sandy and gravelly soils of the adjacent uplands. The delta is composed of alluvial layers of sand, silt, and clay to a depth of 138 feet (CH2M Hill et al. 1978). Tidal soils are very deep, poorly drained soils on which salt-tolerant vegetation grows (Pringle 1982; Burg 1984). Surface sediments of the main river channel are composed of silt mixed with sand, clay, and organic matter (Caicco 1989b).

Soils of the high marsh and sloughs are generally organic with silt, sand, or clay (Caicco 1989b). Sediments of the delta marsh and mudflats have been largely derived from glacial material, which historically and currently have been carried by the Nisqually River from its glacial source on Mount Rainier. The construction of LaGrande Dam in 1910-1912 and completion of Alder Dam midway up the river in 1945 reduced the amount of sediment carried to the delta by the Nisqually River.

Pilchuck loamy sand underlies an area known as the surge plain (see Section 3.2, Vegetation and Habitat Resources) and is then covered by sandy alluvial deposits of the Nisqually River floodplain.

Soils within the diked interior are silt loams of the Pilchuck, Puget, Puyallup, Sultan, and Tacoma series. These soils are compressible, tend toward wetness, and have a high organic content, low strength, and slow permeability (CH2M Hill et al. 1978).

The West Bluff in the Refuge consists of well-drained very gravelly sandy soils on 60 to 90% slopes. The East Bluff is composed of similar soils, moderately to excessively well-drained on 45 to 70% slopes, and are formed in sandy and gravelly outwash (Pringle 1982). In the uplands above East Bluff, known as the Hoffman Hill area, the Kitsap formation is associated with a significant risk of slope failure. In areas of groundwater seepage, steep slopes tend to break off in large blocks (URS Company 1979).

The McAllister Springs basin soils are found in six or so layers of silt, sand, and gravel. Soils consist of glacial till, outwash, and drift, some with peat layers deposited before the Vashon glacier advanced. Soils south of I-5 in the agricultural area are primarily Puyallup silt loams, a dark brown loamy fine sand, and sandy loam. This moderately rapidly draining soil developed in the alluvium, forming floodplain soils. Large pockets of Puget silt loam, a deep, poorly drained soil, are found within depressions in the floodplain soils (Pringle 1982).

3.1.5 Environmental Contaminants

Between 1985 and 1988, the Service conducted four contaminant investigations on the Refuge. As a result of their findings, the Refuge was classified as Category C, which requires reconnaissance monitoring for metals. The justification for the classification was based on the Refuge's proximity to urban areas and a dead bald eagle containing extremely high levels of polychlorinated biphenyls (PCBs) found on the Refuge in 1982 (Momot 1993).

The diked interior along I-5, the orchard, Shannon Slough, and McAllister Creek on the Refuge were documented as areas of potential concern due to elevated levels of arsenic, lead, and mercury. Mice from the Twin Barns contained high levels of lead. Elevated levels of mercury were found at McAllister Creek at I-5, Shannon Slough, and the "red-tailed hawk" pump (Momot 1993). In 1997 and 1998, amphipod tissue studies conducted in the delta detected measurable quantities of heavy metals, especially copper, zinc, and butyltins, in the tissues of amphipods (Davis et al. 1997). However heavy metals detected were below what are considered levels of concern for these organisms. In 1999, the Washington State Department of Ecology tested soils collected from the old orchard area for the presence of arsenic, cadmium, and lead. Results detected no presence of cadmium and very low levels of arsenic and lead (J. Mercuri, pers. comm.).

On the Nisqually Reach, vanadium and aromatic hydrocarbons were found in clams and oysters, and low levels of PCBs were found in ghost shrimp. Elevated concentrations exceeding National Oceanic and Atmospheric Administration (NOAA) standards were also documented for zinc, copper, nickel, and manganese (Momot 1993). Heavy metals and chemicals were found in 1987 and 1992 in sediment chemistry of the Nisqually River delta and reach by the Puget Sound Water Quality Authority. They included aromatic hydrocarbons, PCBs, arsenic, copper, cadmium, mercury, lead, zinc, and total organic carbon (Evans-Hamilton and D.R. Systems 1987; Puget Sound Water Quality Authority 1992). A 1985 study in Puget Sound revealed high levels of contaminants in fish, marine mammals, and marine birds. Great blue heron eggshells from the heronry in the Nisqually River delta were found to be significantly thinner than a pre-1947 mean, likely due to contamination by Dichlorodiphenyltrichloroethane (DDT) or its derivative, DDE (Calambokidis et al. 1985). Aquatic plants, such as eelgrass, appear to concentrate metals without being affected, allowing metals to move through the food web (Phillips 1984).

Since the study area is located in the vicinity of I-5, industrial and commercial operations (such as the gravel mine and gas stations), and residential developments, non-point sources of environmental contaminants exist. In addition, hazardous materials may be transported on I-5, the railroad, or by ship in Puget Sound and have potential for accidental spills, which would affect Refuge lands and waters.

It is Service policy to minimize the potential liability of the Department of the Interior and the Service by acquiring real property that is not contaminated with hazardous waste unless directed by the Congress, court mandate, or as determined by the Secretary of the Interior. In compliance with Service policy, we have conducted an initial overview survey to identify actual or potential hazardous substances or other environmental problems located in areas proposed for Refuge expansion. This is the first step in determining the potential for hazardous wastes prior to

acquisition or land transfer. Additional "Level 1" environmental site assessments are also required prior to the acquisition of any real property to determine the potential of, and extent of liability for hazardous substances or other environmental remediation or injury. This includes but is not limited to a determination of the absence or presence of hazardous substances or conditions that indicate an existing or past release, or a material threat of a release on the real property. The initial site assessment and records search revealed the following:

East Bluff: A portion of the former DuPont Works, an explosives manufacturing plant from 1906 until the mid-1970s, is within the proposed Refuge expansion area. Contamination resulted from the manufacturing process, waste disposal, pesticide use, and decommissioning of the site buildings. In July 1991, Department of Ecology, Weyerhaeuser, and DuPont Companies signed a consent decree to conduct a remedial investigation/risk assessment/feasibility study (RI/RA/FS). The site was divided into two main areas: Parcel 1 (the former production area, about 636 acres) and Parcel 2 (about 205 acres). Parcel 2 (the black powder area or Area 40) was cleaned up to industrial standards and was removed from the 1991 consent decree in August 1997.

A final EIS was issued in July 2000 for a golf course/containment facility in Parcel 1 which would isolate and manage lead and arsenic-contaminated soil (WDOE 2003). The main contaminants of concern are lead and arsenic in soil. While lead was detected site-wide, arsenic contamination, generally from pesticide use, was restricted to more discrete areas. Other hazardous substances discovered are total petroleum hydrocarbons (TPH), mercury, di- and trinitrotoluenes (DNT/TNT), and benzo(a)pyrene. DNT is the only chemical of concern in groundwater and concentrations are generally low, at levels that meet drinking water standards.

The Department of Ecology, Weyerhaeuser, and DuPont Companies have agreed on a cleanup for the former explosives plant. The consent decree, including the cleanup action plan, requires Weyerhaeuser and DuPont Companies to take several actions, which include disposal of higher level-contaminated soils at a hazardous waste landfill, excavating and consolidating lower level-contaminated soil within approximately 90 acres of the planned golf course area, capping it with a 180-acre engineered golf course including 18 inches of clean gravel and soils, and monitoring groundwater. Deed restrictions would limit site use to primarily commercial purposes that will not disturb (WDOE 2003) the cap/cover system and to control groundwater so it will not be used for drinking water. The cleanup regulation also requires the Department of Ecology to review site conditions every five years to make sure that human health and the environment are being protected. The Department of Ecology will oversee the project to ensure that all terms of the consent decree are satisfied.

Expansion Area South of I-5: The portion of the study area managed by the Fort Lewis Military Reservation includes areas used for light training and areas zoned as Research Natural Area. A Level 1 contaminants survey would be conducted prior to the land transfer process.

Other locations in the study area south of I-5 with potential for contaminants include farms, the Holroyd gravel mine, the Nisqually Exit 114 gas stations, and McAllister Creek State Fish Hatchery (now closed). All may have underground or above-ground fuel storage tanks that have potential for leaking or past spills. Other potential contamination may occur in equipment maintenance areas or from pesticide storage and use. Fish hatchery operations may also have

other sources of contaminants that would be investigated in a Level 1 survey prior to acquisition. Initial reconnaissance of the City of Olympia McAllister Springs site has indicated that there is a low probability of contaminants located at this site due to its history as drinking water source for the City.

3.1.5.1 Water Quality

The Nisqually River, from its headwaters on Mount Rainier to Alder Dam (river mile 44), is listed by the Department of Ecology as Class AA, which means that its waters are expected to meet criteria characteristic of extraordinary quality water (Emmett 1995). From Alder Dam to the delta, the river is listed as Class A, with expected criteria characteristic of good and fair quality waters. Water analyses of monitoring stations indicate that significantly higher fecal coliform concentrations occur below river mile 34 (within the mainstem Nisqually River) in comparison to upriver locations, particularly during storm events (Whiley and Walter 1998). This increase is linked to both an increase in nonpoint source fecal coliform loading and to decreased dilution. While significant increases in fecal coliform concentrations were observed for the lower portion of the river, those increases were well within the Washington State Water Quality Standard. The trend in fecal coliform for the lower river indicates that concentrations have reduced over the past 19 years from a median level of 33 colony-forming units (cfu)/100 ml to a present median of 10 cfu/100 ml (Whiley and Walter 1998).

McAllister Creek provides the most continuous source of fecal coliform to the marine areas of the Nisqually Reach (Whiley and Walter 1998). A positive correlation was detected between fecal coliform concentrations within the creek during storm events to corresponding increases in bacterial levels found over shellfish growing areas. In 1992, the Washington State Department of Health reclassified 2,130 acres of commercial and recreational shellfish beds in the Nisqually Reach from "approved" to "conditionally open" after finding elevated levels of fecal coliform bacteria in the reach following storm events (Whiley and Walter 1996; Emmett 1995). Following further evaluation, the shellfish beds were closed to harvest in spring 2000 (W. Clifford, pers. comm.). Water testing is conducted regularly to monitor contaminant levels.

The Nisqually River regularly experiences high turbidity or cloudiness during the summer due to its glacial source. Summer fluvial flows in all rivers and creeks within the CCP Study Area are extremely low and are not supporting existing water rights or fish populations, nor are they reducing the effects of pollutants or providing for recreation. The sand and gravel outwash deposits throughout the aquifer are susceptible to contamination from surface sources, such as land application of wastes (Emmett 1995).

River temperatures on the Nisqually River vary seasonally, with maximums greater than 60.8°F observed in August or September (at the gaging station at river mile 3.4). Minimum temperatures at this station are observed in January or February with values below 42.8°F (ENSR 1999).

Salinity profiles were sampled in 1977 in the Nisqually Reach during low slack water and flood tide (ENSR 1999). Freshwater in this area flows over the marine water in a very thin layer, estimated at 3 to 5 cm. Salinity measurements varied from 0 to 30 parts per thousand (ppt), with the most stratified conditions occurring near the Nisqually mudflats. The Nisqually Reach water

is replaced every 8 days and is considered well flushed (ENSR 1999). Saltwater and tidal influence have been observed from the mouth of Nisqually River to the old US Hwy 99 bridge (river mile 0.0-3.3) (Canning 1986). Salinity ranged from 0 to 6.3 ppt at McAllister Creek from October 1984 to May 1985 (ENSR 1999).

3.1.5.2 Air Quality

The delta is susceptible to localized low level inversions, which can entrap both gaseous and particulate pollutants (Hesselbart 1977b). Stationary sources of air pollution in south Puget Sound include pulp mills, lumber mills, veneer dryers, and sand and gravel companies. North to Seattle and Snohomish County, stationary sources also include steel plants, flour mills, cement plants, aluminum smelters, sawmills, and grain elevators (Washington State Department of Ecology 1991). Deteriorating air quality in the local area is necessitating burn bans of increasing duration and area.

3.2 Vegetation and Habitat Resources

The Nisqually NWR represents an important regional wildlife habitat resource. Information is presented below on important habitats and plant species (including exotic and invasive species) present on the Refuge and in the entire study area. Habitats in the study area include estuarine, freshwater wetland, riverine and riparian, and upland. Figure 3.2-1 is a graphic representation of the habitat types and wildlife typical of the Refuge. This section ends with a discussion of regional trends for important habitats.

3.2.1 Habitats and Vegetation Communities

A habitat type map covering the approved Refuge as well as the entire study area was created based on analysis of a 1997 Landsat Thematic Mapper (TM) image. The amounts of each habitat type present within the approved Refuge boundary, the study area outside the approved Refuge boundary, and within the total study area are presented in Table 3.2-1 and shown in Figure 3.2-2.

Table 3.2-1. Summary of Habitat Types and Acres Within the CCP Study Area.

Habitat	Acres		
	Approved Refuge Boundary	Study Area Outside of Refuge Boundary	Total Study Area
Open Water, Salt	393	43	436
Open Water, Fresh	142	244	386
Unconsolidated Shore	1,115	64	1,179
Aquatic Bed	295	0	295
Vegetated Intertidal	623	10	633
Freshwater Wetland	623	48	671
Riparian and Forested Wetland	259	1,913	2,172
Upland Forest	71	1,262	1,333
Grassland	434	305	739
Agriculture	93	1,108	1,201
Bare Land	0	89	89
Developed	5	304	309
TOTAL ACRES	**4,053**	**5,390**	**9,443**

Source: USFWS data, Ducks Unlimited, and National Wetlands Inventories.
Includes State, Nisqually Indian Tribe, and Private lands. Acres presented in this table were calculated from GIS database; variations in the GIS cover type data result in slight discrepancies in acreage totals presented elsewhere in this CCP/EIS.

3.2.1.1 Estuarine Habitat

The Nisqually River Estuary, one of the most extensive and productive estuaries in Puget Sound, is one of the few remaining vegetated nearshore estuarine habitats in the sound (Copping 1990). Estuarine habitat includes open water, aquatic bed, unconsolidated shore, and vegetated intertidal areas (Figure 3.2-3). The estuary is a complex and highly integrated system that serves as important habitat for migrating waterbirds, waterfowl, shorebirds, raptors, and salmon populations (Thom et al. 1985; URS Company 1979). Estuarine habitats attract a diversity and abundance of wildlife species and provide nursery areas for juvenile salmon and other fish. Many species of plants and animals depend on the delta for one or more phases of their life cycles (Canning 1986).

Historically, the Nisqually delta supported 6,207 acres of intertidal estuarine habitat (Figure 3.2-4). Currently, 5,016 acres of this habitat remains, which represents a loss of 1,191 acres or 19%. Especially significant is the loss of vegetated intertidal habitat or salt marsh, which has decreased from 1,458 acres to 674 acres (a loss of 784 acres or 54%) because of diking, channel migration and straightening, and land filling around I-5 (Tanner 1999). The landward extent of the historical salt marsh, depicted on a 1878 topographic survey map (Bortleson et al. 1980; Figure 3.2-4), reached southwest to Martin Way, just south of I-5. Tidal channels crossed the forested lowland. Since 1878, the Nisqually River channel shifted laterally and straightened from the I-5 crossing to the river mouth (Burg 1984). At the turn of the century, the Brown Farm Dike was constructed and converted estuarine habitat to approximately 1,000 acres of freshwater wetlands and non-native grasslands in the current Refuge boundary (USFWS 1978). The construction of the dike also significantly reduced the amount of shoreline by cutting off the upper reaches of tidal channels and former river distributaries.

The dike is a barrier preventing nutrients, produced in the freshwater wetlands it encompasses, from being released into the estuary. Once an energy and nutrient source to the estuary, the diked interior is now interrupting the physical, chemical, and biological processes of the estuarine system. The alteration of estuarine wetlands to freshwater wetlands by diking has removed habitat for waterfowl, salmon, and other estuarine-dependent species, resulting in detrimental effects (Burg 1984).

The construction of two dams on the Nisqually River reduced the amount of sediment carried to the delta, which may have altered the equilibrium between erosion and deposition toward erosion and recession. The river discharges about 105,000 tons[1] of sediment annually, nearly all of which is currently deposited in Alder Lake (Nelson 1974). The dike may also have caused tidal velocities to increase, resulting in erosion of the mudflats (Consoer et al. 1974; USFWS 1977; Burg 1984; Canning 1986).

[1] Sediment load averages between 250,000 and 300,000 tons annually (USFWS 1977).

Figure 3.2-1 Nisqually National Wildlife Refuge

11 x 17 cross section

Back of Figure 3.2-1

Figure 3.2-2 Refuge Habitats

[color figure]

Figure 3.2-2
Back side of figure

Figure 3.2-3 National Wetland Inventory Regional Estuarine Wetlands

color, 8 ½ x 11

Back of Figure 3.2-3

Figure 3.2-4 Historic and Current Estuarine Wetlands

Back of Figure 3.2-4

Estuarine Vegetation Community Descriptions

Estuarine habitat surrounds the diked area in the delta. Below are described three general categories of estuarine habitat–aquatic bed, unconsolidated shore, and vegetated intertidal–and their distinct vegetation communities (Figure 3.2-2).

Aquatic Bed

Aquatic bed refers to wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season (Cowardin et al. 1979). One of the most important vegetation communities of the aquatic bed in the Nisqually delta is eelgrass beds. Eelgrass provides shelter for fish and invertebrates and is an important source of food for shorebirds, waterfowl, benthic invertebrates, and a large number of other animals. Eelgrass is restricted to habitats where erosion and sedimentation are in equilibrium because its rhizomes tend to grow horizontally (Phillips 1984). The Nisqually River delta is the southern-most source of eelgrass in Puget Sound (T. Mumford, pers. comm.).

Eelgrass beds covering about 49 acres in 1978 were found to occur from the County line northeast to the sandspit on the eastern shore (Wisseman et al. 1978), and covered about 25% of the RNA in the Nisqually Reach (Caicco 1989a). The northeast eelgrass meadows are in the lower intertidal and shallow subtidal areas (Wisseman et al. 1978). The delta front, from the County line to McAllister Creek, is devoid of eelgrass, presumably due to strong tidal scouring action in the reach. High concentrations of eelgrass (22 acres) were found in the McAllister Creek channel in 1978, extending well into the creek mouth and reach (Wisseman et al. 1978). The eelgrass beds in this area are sparsely distributed and less dense than eelgrass beds in other parts of Puget Sound (A. Sewell, pers. comm.).

Unconsolidated Shore (Saltwater)

Unconsolidated shore areas consist of mudflats, sandflats, and rocky shores characterized by a lack of vegetation, except for pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents produce these landforms (Cowardin et al. 1979). These areas attract many wildlife species including shellfish and other invertebrates, shorebirds, and mammals. The delta mudflats and unconsolidated substrate harbor microalgae and over 80 seaweed species. Microalgae, which attaches to sediment, is a possible source of carbon to the detritus-based food web, which plays a primary role in estuarine production (Thom et al. 1985). Sparse mudflat vegetation includes Lyngby's sedge, seashore saltgrass, seaside arrowgrass, fleshy jaumea, and pickleweed (Kunze 1984; Burg et al. 1980). The sparsely vegetated mudflats transition into the more abundant vegetation and dense drainage channels of the low salt marsh (see Vegetated Intertidal, below).

Vegetated Intertidal (Estuarine Emergent)

Vegetated intertidal or estuarine emergent areas are better known as salt marshes. These areas can be further subdivided into low, middle, and high salt marsh communities based on salinity patterns, elevation, and other factors such as substrate, wave energy, marsh age, sedimentation,

and erosion. Low salt marsh generally occurs between the lowest margin of the marsh and mean high water (MHW). Middle salt marsh occurs between MHW and MHHW. High salt marsh occurs between MHHW and the highest margin of the marsh. High salt marsh vegetation typically mixes with upland plant species in the marsh/upland zone (Figure 3.2-1).

Low salt marshes are found on low terraces where the Nisqually River and McAllister Creek meet the reach and in sandy intertidal marsh areas along the outer fringe of the Brown Farm Dike. The topography is hummocky with a diffuse drainage pattern and attracts an abundance of migrating waterfowl species, rails, and bitterns. In the delta toward the reach, low salt marshes are of moderate salinity, with silty and sandy soils. Low to intermediate salt marsh plant communities are dominated by pickleweed, Lyngby's sedge, gumweed, tufted hairgrass, seaside arrowgrass, seashore saltgrass, fleshy jaumea, halberd-leaf saltbush, and scattered patches of Baltic rush (Burg 1984, Burg et al. 1980, Mason et al. 1974). In sandy, low intertidal marsh areas, plant communities include seashore saltgrass and pickleweed (Kunze 1984; WNHP 1998).

The broad, relatively level vegetated areas of the high salt marsh, separated by wide drainage channels up to 6 feet deep were formed by distributaries of the Nisqually River prior to diking (Klotz et al. 1978; Burg 1984). Migrating waterfowl, particularly dabbling ducks, utilize the rich food sources available in these areas. The high salt marsh is composed of plant communities that tolerate low and moderate salinity. Along the river, communities include tufted hairgrass, Baltic rush, Pacific silverweed, Lyngby's sedge, and red fescue (Burg et al. 1980; Burg 1984). Quackgrass, redtop, velvetgrass, and orchardgrass are found high on the banks of McAllister Creek.

D.J. Smith

Salt marsh communities are a primary source of productivity in the estuary.

Salt marsh productivity is dependent upon the health of its vegetation (URS Company 1979). Nisqually salt marsh studies in 1980 showed a production weight recorded for Lyngby's sedge that is among the highest rates recorded for salt marshes in the Pacific Northwest (Thom et al. 1985). Lyngby's sedge, covering roughly 20 acres in the delta, was the most productive plant type at both high and low elevations (Burg et al. 1980).

3.2.1.2 Freshwater Wetland Habitat (Palustrine Emergent)

Freshwater wetlands in the CCP Study Area include permanent and seasonal ponds, marshes, wet meadows, and scrub-shrub habitats. These are also known as palustrine emergent wetlands.

Riverine and riparian wetlands are other types of freshwater wetlands, discussed separately below. Freshwater wetlands provide habitat for a variety of waterfowl (especially dabbling ducks), herons and other waterbirds, shorebirds, landbirds, mammals, amphibians, and invertebrate species.

Since the mid-1800s, a loss of wetlands in the Nisqually River delta and watershed has occurred, not only in estuarine but also in freshwater wetlands (Canning 1986). Freshwater wetland losses have been caused by draining, filling, and diking of lands. Losses are also due to competing activities and practices such as agriculture, grazing, forestry, and recreation (Canning 1986).

When the dike was built in the late 1800s, estuarine habitat was converted to freshwater habitat, increasing freshwater habitat in the delta by 610% (Tanner 1999). With the cessation of agricultural practices, the diked area became progressively wetter. Since Refuge establishment, the diked area has been managed as freshwater wetlands and non-native grasslands.

Freshwater wetlands within the current Refuge boundary are found primarily within the diked area and include permanent and seasonal wetlands, wet meadows, marshes, and scrub-shrub habitats. These wetlands are fed by several artesian wells and rainfall and are found around artesian wells, in low lying depressions, along historically tidal slough channels, and borrow ditches. During high flood conditions, freshwater also flows into the diked area through two overflow channels from the Nisqually River. Normally, there is no direct flow from the Nisqually River or McAllister Creek into the diked area. Saltwater seepage through the dike occurs frequently, allowing both freshwater and brackish vegetation to grow in the borrow ditch and sloughs. Interspersed within the dike's emergent wetlands and seasonally flooded freshwater depressions are non-native grasslands (see Upland Habitat, below).

Vegetation dominating wet meadows commonly includes rushes, cattails, sedges, and grasses. Scrub-shrub vegetation scattered through the marsh areas includes mixed grasses and forbs and is dominated by native shrubs. Aquatic vegetation found in permanent ponds includes pondweeds, smartweeds, knotweeds, bulrushes, sedges, and grasses (Burg 1984).

During the past 20 years, the habitat quality of the diked interior freshwater wetlands at Nisqually has declined. Reed canary grass, a highly invasive exotic plant, is rapidly spreading throughout much of the area and now occupies more than 30% of the total acreage. Water level management has become increasingly limited, and portions of the diked area are becoming too wet to easily manage. Plant succession has been allowed to occur in large sections of the diked area, allowing wetlands and grasslands to gradually convert to scrub-shrub habitats.

Approximately 48 acres of freshwater emergent wetlands occur in the study area outside of the currently approved Refuge boundary. All of these wetlands are found south of I-5. The majority of them occur in the McAllister Creek basin in potholes and upland depressions. Wetland vegetation ranges from sedge stands to cattails, bulrushes, willows, salmonberry, and skunk cabbage (Thurston County Dept. of Water and Waste Management 1993). Other freshwater wetland locations are also found along the Nisqually River and adjacent floodplains.

3.2.1.3 Riverine and Riparian Habitats

This group of habitats includes riverine, freshwater unconsolidated shore, riparian, and forested wetlands areas in the CCP Study Area. They are found within and alongside the Nisqually River, McAllister Creek, and Red Salmon Creek. Natural riverine and riparian corridors are diverse, dynamic, and complex habitats supporting a wide variety of fish and wildlife. Although riparian areas constitute a small portion of the surface landscape, they are very productive, and approximately 85% of Washington's wildlife species have been known to use riparian habitat associated with rivers and streams (Knutsen and Naef 1997). Habitat for many upland species is also directly enhanced by the presence of adjacent riparian and riverine habitat.

Most of the Nisqually River floodplain in the study area is comprised of riparian vegetation (Canning 1986). The original extent, and subsequent loss to conversions, of the riparian forests is unknown. Historically, losses occurred primarily due to timber harvest, livestock grazing, road construction, and reservoir impoundments (Canning 1986). On the Refuge, agricultural fields, roads, and building sites are located on historical riparian and bottomland habitat along the Nisqually River. These disturbed areas have been colonized mainly by non-native grasses and forbs (Klotz et al. 1978).

Riverine and Unconsolidated Shore

Riverine habitat is home to some aquatic plants but is dominated by open water. Unconsolidated shore includes sandflats containing pioneering plants that are periodically disturbed by floods and other erosive events. The Nisqually River provides good wintering habitat for bald eagles (URS Company 1979). A peak count of 200 eagles on the Nisqually River has been observed (Stalmaster 2001). Other species that use the riverine habitat in the study area include several anadromous (migratory) salmonids, such as chinook and chum salmon, and a variety of amphibians, reptiles, and mammals.

L. Gillespie

The riverine and riparian habitats in the Nisqually River are important for a variety of migratory birds and fish.

Riparian and Forested Wetland (Deciduous and Mixed)

Riparian forests in the study area are typically deciduous or mixed forests along the Nisqually River and McAllister Creek. Deciduous riparian forests are dominated by big-leaf maple, black cottonwood, and red alder. In areas in which coniferous tree species are present (mixed forests), Douglas-fir or western red cedar are typical. Understory vegetation includes salmonberry, snowberry, Indian plum, and red-osier dogwood. Riparian vegetation along the upper McAllister Creek grows in a broad wetland with some saltwater intrusion. Vegetation consists of willows, red elderberry, ninebark, and Indian plum. From the middle reach of the creek to the estuary, agricultural dikes and lawns with scattered wetland plants occur, as well as riparian

habitat limited to narrow bands along the streambanks (Thurston County Dept. of Water and Waste Management 1993). Riparian areas provide habitat for more bird species, including passerines, woodpeckers, waterfowl, and raptors, than all other habitat types combined (Knopf et al. 1988; Kirby et al. 1992).

Within the Refuge, a high quality example of a surge plain—a high energy, high nutrient, tidal freshwater forested wetland–can be found along the Nisqually River. The approximately 70-acre forested wetland community is regularly influenced by tidal waters. The surge plain is flooded during high tides and freshwater storm events. Between inundating floods and high tides, the forested wetlands remain wet to saturated by slightly brackish water and freshwater, and the water table is near the surface (Washington Natural Heritage Program [WNHP] 1998; Caicco 1989a). The surge plain consists primarily of deciduous forests with small pockets of mixed canopy. The deciduous stands are dominated by black cottonwood, big-leaf maple, red alder, with a very dense shrub layer (Caicco 1989a). The shrub layer consists of two communities—one dominated by common snowberry and the other by salmonberry (Klotz et al. 1978; Caicco 1989a). Other plants found in the understory include various willow species, vine maple, red-osier dogwood, Oregon ash, and red elderberry (Caicco 1989a; URS Company 1979).

3.2.1.4 Upland Habitat

Upland habitat consists of lands not inundated by water except during catastrophic events. Upland habitat in the CCP Study Area includes upland forest, grassland, and agricultural land. Most of the upland areas within the approved Refuge boundary are in the southwestern portions of the diked area, on the western property above the bluffs, the eastern hillside near Mounts Road, and the area around the Refuge administrative buildings and parking lot. Upland areas within the study area outside the Refuge boundary include the bluffs along the Nisqually River, McAllister Creek and along the eastern boundary of the Refuge, and agricultural lands in the valley. Upland forest habitats support a variety of nesting birds, including the bald eagle, red-tailed hawk, great blue heron, woodpeckers, and passerines, as well as mammals and amphibians. Agricultural lands and grasslands, depending on specific management regime, can be good foraging areas for some landbirds, shorebirds, and waterfowl.

Within the Refuge, upland forests were formerly highly diverse and probably contained western hemlock, western red cedar, and Douglas-fir, which flourished in openings created by fire, wind, drought, insect damage, and disease (Thurston County Dept. of Water and Waste Management 1993). By the mid-1800s, the upland forests were cleared as settlers created fields for cultivation amidst transitional freshwater wetlands (Burg 1984). Forests throughout the Puget Sound lowlands, including the Nisqually River watershed, have been heavily affected by logging (Cassidy 1998). Red alder, which was much less common before settlement and logging of the delta, is now more abundant (URS Company 1979). The overall reduction in structure and complexity of forests in the watershed compared to their historical counterparts may offer less stormwater protection and habitat diversity (Thurston County Dept. of Water and Waste Management 1993).

Soil map analysis of the study area suggests that prior to European settlement, forested uplands and riparian forested bottomlands grew adjacent to the estuarine wetlands of the delta. Native grasslands were, at that time, restricted to uplands and prairies south and east of the delta.

Upland Forest

The Refuge and study area lie entirely within the Puget Sound Douglas-fir ecoregion/vegetation zone, adjacent to the Woodland/Prairie Mosaic zone on Fort Lewis. Forests cover about 87 acres of the Nisqually delta and bluffs (Klotz et al. 1978). The delta bluffs are dominated by mixed coniferous-deciduous upland forests (USFWS 1977). Forests along the west delta bluffs are mixed deciduous-conifer species. Douglas-fir is predominant, mixed with big-leaf maple, western hemlock, and red alder at lower levels on the bluffs. The upland area adjacent to the West Bluff between Meridian Road and the top of the bluff was historically a dense forest of Douglas-fir, western hemlock, and some western red cedar. Most of the trees were clearcut from the southern two-thirds of the property in the early 1990s, before the 110-acre tract was purchased in 1996 by the Service. The parcel has since reverted to a field of Scot's broom with some occurrences of natural revegetation. The uplands were acquired by the Refuge as a wildlife corridor to the West Bluff and to stabilize the slope above the creek and protect the biological and aesthetic integrity of the Refuge. Reforestation efforts were initiated in the late 1990s.

Forests in the remainder of the study area are comprised of second-growth coniferous and mixed forests (Thurston County Dept. of Water and Waste Management 1993). The bluff along the eastern boundary of the Refuge and along McAllister Creek south of I-5 is dominated by coniferous trees, primarily Douglas-fir. Mixed deciduous forests are scattered along the Nisqually Valley lowlands.

Grassland

Approximately 230 acres of the diked interior are former pastures that were historically extensively cultivated and heavily grazed. Today, pasture grasses that dominate these areas and elevations of these former pasture lands fluctuate slightly with distinct vegetation changes, creating a mixture of non-native grasslands and wet meadows. In lower depressional areas of the diked interior, non-native grasses, such as creeping bentgrass and common velvetgrass, and occasional stands of rushes are found (Mason et al. 1974). Reed canary grass dominates the transition zone between former pasture land and wet meadows, comprising more than 30% of the diked interior.

Since 1974, between 75 and 450 acres have been mowed or hayed each year each to control reed canary grass and provide fall browse vegetation for waterfowl, particularly American wigeon. The area mowed or hayed varies from year to year, depending on rainfall. Currently, approximately 300 to 350 acres are mowed or hayed each year.

Agriculture

With over 1,100 acres in crops and pasture in the CCP Study Area outside of the Refuge boundary, agriculture is one of the predominant land uses south of I-5. The principal crops grown in this area include hay, corn, and Christmas tree farms. To maintain the existing rural environment of the Nisqually Valley, agricultural lands in this area became part of Thurston County's Purchase of Development Rights (PDR) program since 1994 (S. Morrison, pers. comm.; Thurston County Planning Department 1992). The PDR program permanently preserves farmland while supporting the farming community.

3.2.2 State and Regional Trends for Key Habitats Represented at Nisqually NWR

Historically, presettlement wetland acreage in Washington ranged from 1.17 to 1.53 million acres (Lane and Taylor 1996). Estimates of wetland loss in Washington range from 20 to as great as 50% decline during the past 200 years due to dredging, filling, diking, and industrial and residential development (Lane and Taylor 1996). The Puget Sound area has experienced even greater losses of up to 70 to 100% of historic wetlands in some urbanized areas (White 1997; Lane and Taylor 1996). Freshwater wetlands throughout the state were subject to a high rate of loss until the 1940s. Since then, the trend of wetland loss has slowed considerably since fewer wetlands remain to be converted, particularly in urbanized areas (Boule et al. 1983; Lane and Taylor 1996). Of the estimated 900,000 acres of wetlands currently in Washington State, about 22% are estuarine and 78% are freshwater (also known as palustrine) (Boule et al. 1983; Lane and Taylor 1996).

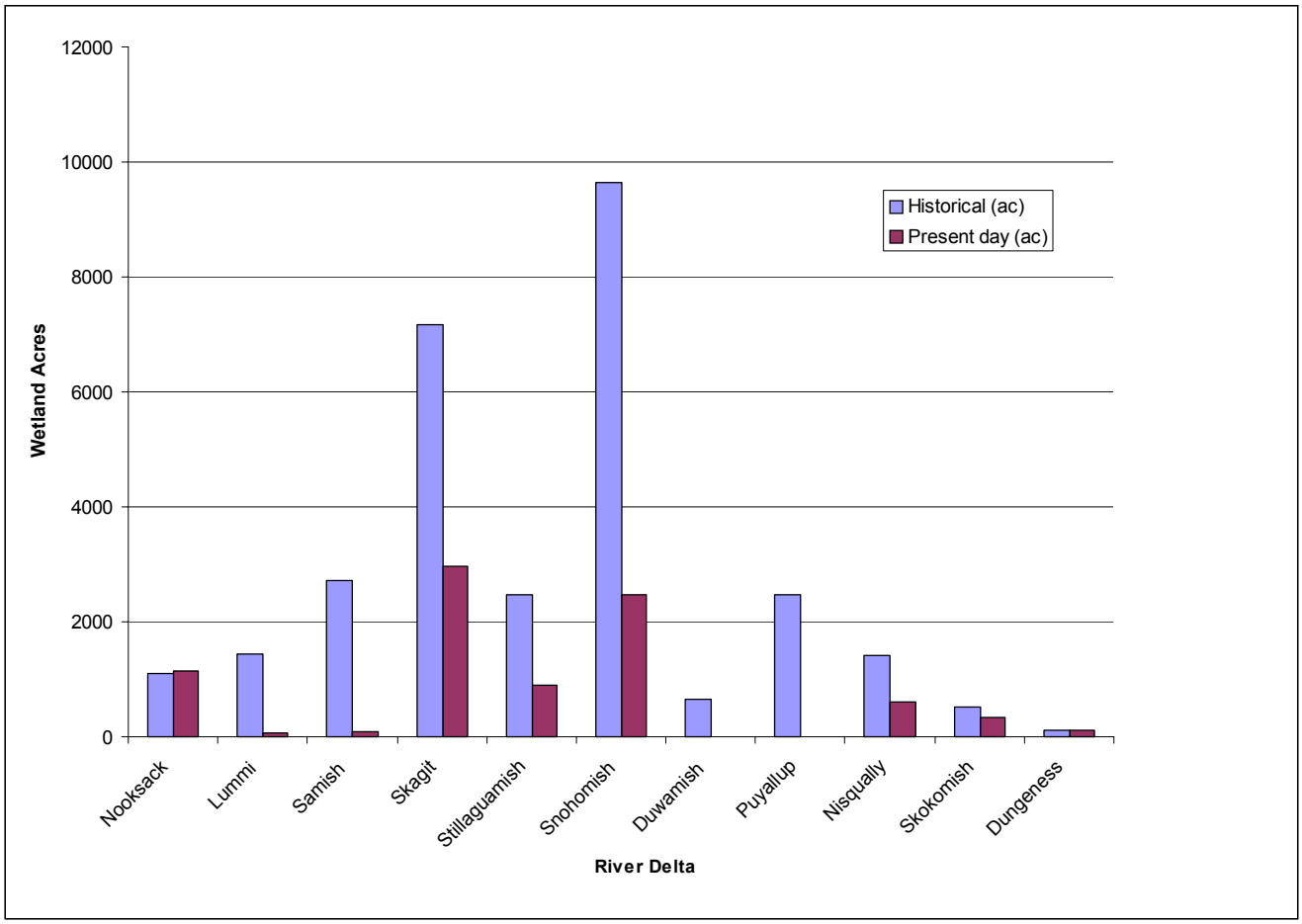
Over 80% of estuarine wetlands in Puget Sound, and up to 33% of its eelgrass beds, have been lost (White 1997; Lane and Taylor 1996; Dean et al. 2000). In south Puget Sound, estuarine intertidal areas comprise only 6% of wetland areas and are dominated by vast expanses of shoreline (Tanner 1999). Figure 3.2-5 shows large overall losses in salt marsh acreage for 11 major river deltas in Puget Sound. Currently, salt marsh habitat is one of the smallest wetland components, comprising just 0.3% or approximately 1,529 acres of wetland and deepwater resources in the south Puget Sound region (Tanner 1999).

Roughly 500 to 1,000 acres of freshwater wetlands are filled each year in western Washington (White 1997). Current loss and degradation of freshwater wetlands in western Washington are due to urban expansion, forestry and agricultural practices, industrial development, and invasive or exotic plants and animals (Lane and Taylor 1996). Currently, freshwater wetlands comprise a significant component (18%) of wetlands in the south Puget Sound region (Tanner 1999). Freshwater wetlands in the region are dominated by vegetated wetland classes, with emergent wetlands comprising 35% of all freshwater wetlands found in this region (Tanner 1999).

3.2.3 Plants, Including Exotic and Invasive Species

A list of plant species found on the Refuge is located in Appendix E.1. There are no rare plants inhabiting the Refuge or study area. As many as 437 species of plants have been recorded on the Refuge (USFWS data). These include a variety of forbs, trees, shrubs, grasses, and sedges. The most abundant group of plants are forbs, with over 200 species. Shrubs are the next most

Figure 3.2-5. Overall losses in salt marsh acres for Puget Sound river deltas.



abundant, with 60 species. The number of species of grasses and trees is similar, with about 35 species each. An inventory of plants within the study area has not been conducted. See Habitats and Vegetation Communities, above, for examples of plant species found in various habitat types.

Nisqually NWR has numerous invasive weed species that compete aggressively with native plant communities. One species in particular, reed canary grass, has invaded most non-forested freshwater wetlands. Figure 3.2-6 displays the best available data showing the distribution of reed canary grass on the Refuge.

Canary grass grows under a variety of moisture conditions; however, optimal growth occurs on moist or wet soils, particularly in wetlands. Canary grass infestations establish quickly and expand rapidly. Because canary grass is highly competitive, it poses a major threat to native wetland vegetation. Many wetlands throughout the Pacific Northwest have become infested with dense, monotypic stands of canary grass, resulting in decreased diversity of flora and fauna.

Figure 3.2-6: Invasive Reed Canary Grass

[Color Figure]

Back of Figure 3.2-6

In 1997, reed canary grass dominated at least 30% of the diked interior and it continues to spread rapidly. Effective control is extremely difficult and costly, requiring an intensive combination of mowing, discing, prolonged and deep flooding, and herbicide application.

Other weed species are monitored and controlled annually to prevent them from taking over Refuge habitats. Scot's broom was introduced to the Pacific coast as a garden ornamental by early settlers. Scot's broom aggressively grows into dense, pure stands eliminating native forbs, grasses, or young trees. In Washington, this plant interferes with re-establishment of conifer seedlings on harvested lands. Other pest species include common reed, poison hemlock, rush skeletonweed, gorse, Canada thistle, and tansy ragwort. The Refuge is surveyed throughout the year for the presence of these species, and plants are removed manually. The non-native Himalayan blackberry is an aggressive invader of pastures and seasonal freshwater wetlands, forming dense monotypic stands. Control requires aggressive measures including mowing, discing, scraping, hand removal, and herbicide application.

3.3 Fisheries Habitats and Resources

As many as 94 species of fishes from 30 different families have been observed in the Nisqually Basin, Estuary, and Reach (Cook-Tabor 1999). These species include salmonids, lamprey, herring, smelt, cods, sculpins, rockfish, surfperches, pricklebacks, gobies, sandlances, flounders, and flatfishes. There are few freshwater species residing in the Nisqually River, McAllister Creek, and associated tributaries that would be affected by this plan. To simplify and focus the discussion of the effects of the CCP alternatives on fish (presented in Chapter 4), this description focuses on the selected species listed in Table 3.3-1 below (see Wildlife Species List, Appendix E.2). All of these species are considered indicators of estuarine environmental health and are meant to represent the broader set of fish species using estuarine habitats of the Refuge and study area (Emmett et al. 1991). The species listed in the following table are described below by species group, with potential effects addressed in Chapter 4.

Table 3.3-1. Species Selected for Evaluating the Likely Effects of CCP Alternatives on Fish Inhabiting the Estuarine Habitats of the Refuge.

Species Group	Family
1. Pacific Salmon	
Chinook salmon *(Oncorhynchus tshawytscha)*	Salmonidae, trouts
Chum salmon *(O. keta)*	Salmonidae, trouts
Coho salmon *(O. kisutch)*	Salmonidae, trouts
2. Forage Fish	
Pacific herring *(Clupea harengus)*	Clupeidae, herrings
Surf smelt *(Hypomesus prettiosus)*	Osmeridae, smelts
Pacific sand lance *(Ammodytes hexapterus)*	Ammodytidae, sand lances
3. Other Fishes	
White sturgeon (*Acipenser transmontanus*)	Acipenseridae
Bull trout *(Salvelinus confluentus)*	Salmonidae, trouts
Pacific tomcod *(Microgadus proximus)*	Gadidae, cods
Pacific staghorn sculpin *(Leptocottus armatus)*	Cottidae, sculpins
Shiner perch *(Cymatogaster aggregata)*	Embiotocidae, surfperches
Arrow goby *(Clevelandia ios)*	Gobiidae, gobies
Starry flounder *(Platichthys stellatus)*	Pleuronectidae, righteye flounders
English sole *(P. vetulus)*	Pleuronectidae, righteye flounders

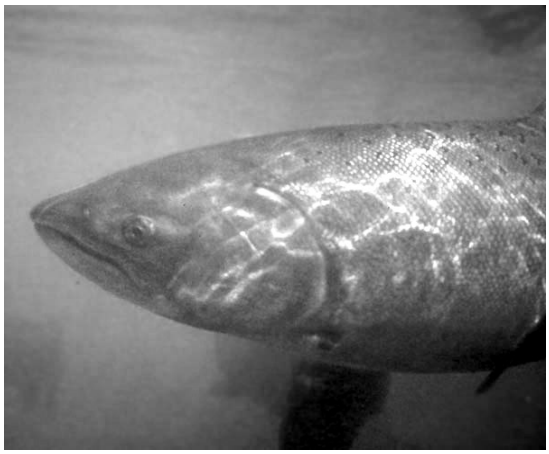
3.3.1 Pacific Salmon

Salmonids are probably the most abundant fishes in the Nisqually River Basin, with ten species found in the Nisqually River and Estuary, McAllister Creek, and independent tributaries. Six of the salmonids observed in the Nisqually Basin are Pacific salmon. Pacific salmon are an integral component of the Pacific Northwest, supporting industry, recreation, and culture (Nehlsen et al. 1991). The Pacific salmon runs present in the Nisqually River include summer/fall chinook, winter chum, coho, and pink salmon, and cutthroat and winter steelhead. Chum salmon are the most abundant species, followed by coho salmon, pink salmon, steelhead, and chinook salmon. Due to high numbers of releases of hatchery fish in the Nisqually River Basin, the summer/fall chinook and coho salmon runs are considered to be of mixed hatchery/native origin. All other Pacific salmon runs are of native origin.

Extensive losses of salmonid populations throughout the Pacific have occurred over the last 150 years. Adverse effects of habitat alterations, dams, and hatchery operations are widely recognized as major contributors to the decline of salmon in the region. Nehlsen et al. (1991) associate these activities with over 90% of the documented stock extinctions or declines. The importance of habitat is underscored in coastal watersheds with declining salmon populations.

The generalized life history of Pacific salmon includes spawning in freshwater, migration through estuaries to the ocean, and subsequent maturation and migration back to freshwater for spawning. Juveniles migrate from the river to the estuary primarily during spring and early summer, and the occurrence of juvenile salmon within different estuarine habitats varies by time, species, and size, with species residing in estuaries from a few days to many months. Of the Pacific salmon found in the Nisqually River, chinook salmon are the most dependent on estuaries to complete their life cycle, followed by chum, pink, and coho salmon, and coastal cutthroat trout (Aitkin 1998).

Estuaries provide important habitat for foraging, predator avoidance, and for the physiological transition from fresh to saltwater (Healey 1982; Simenstad et al. 1982; Iwata and Komatsu 1984). Juvenile anadromous salmonids use intertidal and shallow subtidal sloughs and tidal channels during the critical transition from spawning habitats in freshwater to the marine feeding grounds of the north Pacific Ocean (Simenstad et al. 1992). Juvenile salmonids congregate in areas where estuary morphology favors detritus retention, such as weed beds and channels with braided and meandering morphology (Healey 1982).



D. Vogel

Chinook salmon are the largest of the Pacific salmon and are highly dependent on estuaries.

Chinook salmon, also known as king salmon, are the largest of the Pacific salmon. Nisqually River chinook salmon are included, with 27 other distinct stocks, in the Puget Sound evolutionarily significant unit (ESU) determined by NMFS (Myers et al. 1998; Stout et al. 2001). Abundance of native chinook salmon in this ESU has declined substantially; NMFS has determined this ESU to be

at risk of becoming endangered within the foreseeable future and listed this ESU as threatened under the Endangered Species Act (ESA) in 1999 (63 FR 11482).

Chinook salmon have the most diverse life history strategies of the Pacific salmon (Myers et al. 1998) and remain at sea commonly from 2 to 4 years, with some proportion remaining as little as 2 or 3 months or as long as 6 years (Gilbert 1912; Mullen et al. 1992). The majority of juvenile chinook salmon out-migration to the estuary has been found to occur between mid-February and early June (Williams et al. 1975). The principal prey items eaten by juvenile chinook salmon in the estuary were insects (primarily dipteran flies) as well as spiders, decapod zoea, harpacticoid copepods, amphipods, and fish (Pearce et al. 1982). The highest growth rates for juvenile chinook salmon have been recorded in estuaries (Simenstad et al. 1982). Results of studies in the Sacramento River and Skagit River systems suggest that juvenile chinook salmon reared in estuaries grow faster than chinook salmon reared in upper river habitat, and this may increase their marine survival (Kjelson et al. 1982; Congleton et al. 1982). Tag recovery data from hatchery fish indicate that juvenile chinook salmon originating from other river systems in south Puget Sound utilize the Nisqually Estuary (Pearce et al. 1982).

Winter chum salmon in the Nisqually River are considered native in origin. The main prey of juvenile chum salmon in the Nisqually River Estuary was found to shift over the period of out-migration from bottom-dwelling prey, primarily harpacticoid copepods and gammarid amphipods, to prey found in shallow waters, such as calanoid copepods, crustacea larvae, and hyperiid amphipods (Fresh et al. 1979; Pearce et al. 1982).

Nisqually River coho salmon were included in the Puget Sound/Strait of Georgia ESU determined by NMFS in their status review of coho salmon stocks of Washington, Oregon, and California (Weitkamp et al. 1995). This ESU is under consideration for listing (candidate species) under the ESA due to the continuing loss of habitat, high artificial production rates, high harvest rates, and a severe decline in average size of spawners. Coho salmon juveniles remain in the system for more than 1 year, rearing in the accessible length and tributaries of the Nisqually River, the independent tributaries of the south shore of the Nisqually Reach, and McAllister Creek (Williams et al. 1975). The majority of out-migration to saltwater occurs between late February and early June. Juvenile coho salmon located in shallow sublittoral (water zone to about 600 feet) habitat in the Nisqually Reach feed primarily upon bottom-dwelling organisms, such as gammarid amphipods, harpacticoid copepods, cumaceans, isopods, and mysids, as well as sand lance and surface drift insects (Fresh et al. 1979; Pearce et al. 1982).

3.3.2 Forage Fish

Herring species observed in the Nisqually River, Estuary, and Reach include American shad, a non-native species, and Pacific herring (Fresh et al. 1979; Pearce et al. 1982). Pacific herring are a significant part of the prey base of finfish, marine mammals, and sea birds of Puget Sound (Lemberg et al. 1997; Stewart 1977; West 1997). The herring found utilizing the Nisqually Reach and Estuary is the Squaxin Pass stock, the southernmost stock in Puget Sound (Lemberg et al. 1997). A Biological Review Team (BRT) from NMFS reviewed the declining status of Pacific herring in Puget Sound and concluded that it is neither at risk of extinction, nor likely to

become so. However, the report also found that there is evidence pointing to the potential for human-caused factors to be disrupting the Puget Sound ecosystem (Stout et al. 2001).

Prior to spawning, adult herring hold in the Nisqually Reach and, once ready, spawn in south Puget Sound from mid-January to mid-April (Lemberg et al. 1997). Herring usually deposit eggs on intertidal and shallow subtidal eelgrass and marine algae. Juveniles remain in nearshore shallow-water areas until fall, when most disperse to deeper off-shore waters. Alterations of water quality, prey species, spawning substrate, and habitat can also affect populations. Puget Sound herring reside in an increasingly urbanized and threatened environment and are particularly susceptible to influences of shoreline development (O'Tool et al. 2000). The maintenance of these stocks is dependent upon protection of their critical habitats—intertidal and shallow subtidal locations.

Surf smelt in all life stages are found in estuarine and marine waters (Emmett et al. 1991). They are a significant part of the total Puget Sound forage base (Lemberg et al. 1997). Surf smelt spawn in 2.5 to 5 cm of water in the upper intertidal zone, depositing eggs that stick to sand (Emmett et al. 1991). Surf smelt spawning habitat has been documented in the Nisqually Estuary (Lemberg et al. 1997). Due to its strict spawning habitat requirements, this species is considered an indicator of environmental health (Emmett et al. 1991).

Pacific sand lance have been observed in very large numbers in the Nisqually Reach and Estuary (Fresh et al. 1979; Pearce et al. 1982). Sand lance spawn within the upper intertidal zone (Emmett et al. 1991; Lemberg et al. 1997). Sand lance can be an important component of sea birds and salmon prey bases, with reports of 19 to 53% of the diet of coho, sockeye, and chinook salmon consisting of sand lance (Beacham 1986; Manzer 1969; Pearce et al. 1982). Due to their importance as prey for many species of marine vertebrates and sensitivity to oil-contaminated sediments, Pacific sand lance are considered an indicator species of environmental stress (Emmett et al. 1991).

3.3.3 Other Fishes

White sturgeon are anadromous, spawning in large rivers and residing in both marine and fresh water. This species tolerates a wide range of saltwater concentrations and is common in estuaries of large rivers of the Pacific coast. Larvae and very young juveniles are riverine, while older juveniles and adults are found in riverine, estuarine, and marine habitats. White sturgeon are not usually found in intertidal areas, although they may feed on intertidal flats at high tide. Juvenile and adult white sturgeon are primarily carnivorous benthic feeders. This species is considered an indicator of environmental stress because it is long-lived and may concentrate contaminants. White sturgeon are considered to be a priority species for conservation and management by WDFW.

Pacific tomcod spawn from late winter to spring in Washington in marine coastal waters (Emmett et al. 1991; Walters 1984). Larvae and small juveniles are pelagic (i.e., free swimming in open water) occurring in nearshore marine waters and estuaries, while adults and juveniles are demersal (i.e., near the bottom of the ocean) in salinities above 18 ppt. Pacific tomcod larvae are

consumed by many fishes, while juveniles and adults are eaten by large fishes, harbor seals, and other marine mammals (Emmett et al. 1991).

Sculpin are small to moderate-sized bottom-dwelling fishes (Hart 1973). Twenty-two freshwater, marine, and estuarine species of sculpin have been observed in the Nisqually River, Estuary, and Reach (Cook-Tabor 1999). Of these species, the Pacific staghorn sculpin is considered an indicator species of environmental health and is usually found in shallow water (<50 m) in the sand or mud (Emmett et al. 1991; Love 1991). Large numbers of Pacific staghorn sculpin have been found in the Nisqually Reach and Estuary (Fresh et al. 1979; Pearce et al. 1982). Pacific staghorn sculpin feed at high tide on mudflats (Love 1991) and are eaten by large fishes, birds, and mammals.

Most surfperches inhabit shallow intertidal locations along sandy or muddy shores (Lamb and Edgell 1986). Unlike most fish, they bear large and fully developed young. Shiner perch, striped seaperch, and pile perch have been found in the Nisqually Estuary and Reach with shiner perch in large numbers (Fresh et al. 1979; Perce et al. 1982). Shiner perch are considered an indicator species of environmental health. They are commonly associated with docks and pilings and aquatic vegetation (eelgrass) in nearshore intertidal and subtidal areas with depths of less than 50 feet (Emmett et al. 1991; Love 1991). Shiner perch move into shallow bays and estuaries in spring and summer, and offshore into deeper water in fall and winter (Emmett et al. 1991) and are eaten by large marine fishes, marine mammals, and fish-eating birds.

Most gobies live in shallow to moderately deep coastal waters and prefer sandy, silty bays and tideflats (Lamb and Edgell 1986). Gobies are active bottom-dwelling and small-sized fish. The arrow goby is considered to be an indicator of environmental stress because it depends on estuaries (Emmett et al. 1991). They spawn year round on intertidal mudflats or sand flats of estuaries. Arrow gobies are eaten by birds and other fish (Lamb and Edgell 1986).

Nine righteye flounder species occur in the Nisqually Estuary and Reach (Cook-Tabor 1999). Of those species, Dover sole, rock sole, butter sole, English sole, and sand sole are considered common or of economic importance by WDFW (Palsson et al. 1997). Very large numbers (~10,000) of starry flounders have been captured in the Nisqually Estuary and Reach (Fresh et al. 1979; Pearce et al. 1982). Puget Sound stocks spawn between February and April near river mouths and sloughs in shallow water (Emmett et al. 1991). Juveniles most commonly live in estuaries in shallow water and are also found in sandy, intertidal, and freshwater areas. Starry flounder are preyed upon by marine mammals and fish-eating birds (Emmett et al. 1991; Love 1991).

English sole in Puget Sound spawn from January to April over soft-bottom substrates at depths of 50 to 70 m (Emmett et al. 1991). Larvae are transported to nearshore nursery areas (primarily estuaries) by tidal currents, feed on plankton, and metamorphose into juveniles in spring and early summer. Due to its reliance on estuaries for rearing, alterations and pollution of estuarine habitats adversely affect English sole (Gunderson et al. 1990). English sole are eaten by larger fishes, marine mammals, and fish-eating birds.

3.3.4 Threatened and Endangered Fish

Threatened and endangered fish species present in the Nisqually Basin include chinook salmon, coho salmon (a Candidate species), as well as bull trout. Information regarding chinook and coho salmon is presented in Section 3.3.1.

Bull trout have historically occurred in the Nisqually River watershed. Bull trout are closely related to Dolly Varden. Bull trout populations are threatened by habitat degradation, dams and diversion, and predation by non-native fish. The anadromous form of bull trout is the least understood and documented of the four life history forms (resident, fluvial, adfluvial, and anadromous) (USFWS 1998). Adult fish have been occasionally seen in lower sections of Puget Sound rivers, Grays Harbor, and Skagit River estuaries and are presumed to be anadromous forms (Brix et al. 1974; Kraemer 1994; WDFW 1998).

Habitat is available in the Nisqually River for all life history forms: anadromous, fluvial, adfluvial, and resident. Not much is known about the native char in the Nisqually River system. Bull trout/Dolly Varden were described as entering the Nisqually River in "vast numbers" in historical accounts (Suckley and Cooper 1860), but little is known about the current status of the population (WDFW 1998). The anadromous form of bull trout, if present in the Nisqually River, is likely only in small numbers (J. Michaels, pers. comm.).

Bull trout within the Coastal/Puget Sound Distinct Population Segment (DPS) were listed as threatened under the Endangered Species Act on 1 November 1999 (64 FR 58909). Based on their geographic distribution, WDFW classified Nisqually River bull trout as “distinct” from other Puget Sound char stocks in their Salmonid Stock Inventory (WDFW 1998). Due to insufficient information, the stock status was classified as “unknown.”

Bull trout generally spawn from August through November in small tributaries and headwater streams. Because bull trout eggs incubate about 7 months in loose, clean gravel, they are especially vulnerable to fine sediments and water quality degradation (Fraley and Shepard 1989). Hatching occurs in late winter or early spring (Rieman and McIntyre 1993). Anadromous bull trout juveniles typically spend 2 to 3 years rearing in tributary streams before migrating to sea. Bull trout eat aquatic and terrestrial insects, macrozooplankton, mysids, and fish (Shepard et al. 1984). Large bull trout may feed almost exclusively on fish (Fraley and Shepard 1989; Shepard et al. 1984).

Bull trout distribution has been reduced by an estimated 40 to 60% since pre-settlement times, due primarily to local extirpations, habitat degradation, and isolating factors. In general, bull trout need habitat providing cold water, complex cover, stable substrate with a low percentage of fine sediments, high channel stability, and stream/population connectivity (Fraley and Shepard 1989; Rieman and McIntyre 1993; USFWS 1998). Bull trout also readily interbreed with non-native brook trout, causing genetic introgression. Brook trout may also exclude bull trout from native habitats (USFWS 1998). In addition, native char are easily caught and are highly susceptible to fishing pressure (Fraley and Shepard 1989).

3.4 Wildlife

The mosaic of saltwater estuary, freshwater wetlands, riparian, and open or forested upland habitats at Nisqually NWR results in a diversity of more than 300 species of birds, mammals, reptiles, and amphibians (see Wildlife Species List, Appendix E.2). The Nisqually delta is an important non-coastal resting and feeding area for migrating waterfowl and shorebirds between the Skagit Flats and the Columbia River within the Pacific Flyway. Eelgrass beds and tidal mudflats provide feeding and roosting areas for migrating waterfowl and shorebirds. Some birds in the estuarine and freshwater ecosystem are year-round residents, or remain for the summer or winter season at the end of their migrations. The Nisqually Estuary is rich in microorganisms and invertebrates that support a variety of wildlife including waterfowl, shorebirds, waterbirds, marine mammals, and shellfish. Located in the lower Nisqually River watershed, the larger study area also provides freshwater, riparian, and upland habitats for a variety of wildlife.

3.4.1 Waterfowl

Waterfowl migrating in the Pacific Flyway begin arriving on the Nisqually delta in late September, with many remaining through the winter. While some birds may use the area only for short periods of time during migration, they are dependent upon the area and its rich food sources. Other birds remain for the winter on the delta, traveling between the estuary and flooded agricultural or grass fields and wetlands on or off the Refuge. Off-Refuge sites are primarily found south of I-5. Nisqually NWR staff have been conducting aerial surveys to monitor waterfowl population numbers on the Refuge since 1975. Since 1984, waterfowl data were collected in association with five distinct survey units (Figure 3.4-1): (1) McAllister Creek, (2) Nisqually tideflats, (3) diked area, (4) Nisqually River and east side estuarine habitats, and (5) northwest shoreline to Johnson Point.

Dabbling ducks comprise more than 90% of all Refuge waterfowl sightings. Peak population numbers were observed during October or November with an average of 5,125 birds observed annually (1984-2000). The highest annual average was 9,641 in 1994 and the lowest was 1,630 in 1997. The American wigeon was the most abundant (76% of all dabblers) waterfowl species observed on the Refuge. Numbers of wigeon observed peaked at 12,813 in November 1987 but have been declining in recent years. About 90% of wigeon are found in Units 1, 2, and 4, which are primarily estuarine. The remaining 10% of average wigeon numbers were found in diked habitats in Unit 3.

C. Vadai

The American wigeon is the most abundant waterfowl species found on the Refuge.

Other commonly observed dabblers include mallard, northern pintail, and green-winged teal. Dabblers consume vegetation mainly

Figure 3.4-1. Waterfowl Survey Units

Back of Figure 3.4-1

in shallow water, on mudflats, and in the salt marsh. Dabblers, as well as other waterfowl, feed on species such as eelgrass and wigeon grass present in the estuary (Klotz et al. 1978). In the fall and winter, during hunting season, a majority of the delta waterfowl rest far out on the reach. When not on the outer reach, they may rest and drink in freshwater wetlands during the day (i.e., in the Nisqually Valley and move out to the salt marsh to feed at the tide's edge throughout the night) (Berge et al. 1974; Shanewise 1996). Some animal foods, including crustaceans, insects, and mollusks, comprise a small component of their fall and winter diets. Most of the dabbling ducks feed primarily on seeds of aquatic plants, but the American wigeon prefers stems and leafy portions. Berge et al. (1974) stated that large numbers of waterfowl were seen on the reach in November, indicating that American wigeon, pintail, green-winged teal, and northern shoveler, among other waterfowl, opted for the estuarine areas over the diked interior. The inner diked areas of the Refuge are used by wigeon and other waterfowl in smaller numbers, especially during the period when seasonally flooded ponds are present. When the dike was breached in 1975 and the diked interior remained flooded in a brackish or altered estuarine state for a year and a half, it was heavily used by waterbirds (Klotz et al. 1978). Plants in the inner diked areas that are primary foods of waterfowl include pondweed, smartweed, bulrush, and grasses (Klotz et al. 1978).

Other waterfowl commonly observed on the Refuge include Canada geese, northern shovelers, bufflehead, and scoter. Both migratory and resident Canada geese subspecies are observed on the Refuge. Migratory Canada geese (primarily cackling subspecies) are present during fall and winter months, while resident (western subspecies) are present in much smaller numbers throughout the year. Observations of geese, primarily migrating subspecies, have increased since the early 1990s. The number of geese observed during winter waterfowl surveys peaked at 687 in 2000. Most Canada geese are observed in grassland areas of Unit 3. Northern shovelers are filter feeders in shallow water and consume a greater amount of small aquatic animals than other surface feeders (Klotz et al. 1978). Small numbers are commonly observed in ponds located in the inner diked area (Unit 3). Scoter are observed most often in Unit 2. Diets of scoter primarily consist of mollusks but can include decapods (crabs, shrimp), amphipods, barnacles, insects, fish, and plants (Klotz et al. 1978). Bufflehead feed on similar items, with insects making up a more important component of their diet. Bufflehead are observed most often in Units 4 and 2. Seaducks, including scoter and scaup, have declined in Puget Sound according to WDFW surveys (Nysewander and Evenson 1998).

Waterfowl are also found in the study area south of the Refuge, primarily in freshwater wetlands and seasonally flooded agricultural fields. Many waterfowl species travel between the delta estuary and freshwater habitats south of the Refuge.

3.4.2 Waterbirds and Seabirds

Waterbirds and seabirds commonly observed on the Refuge include great blue and green herons, American bittern, American coots, Virginia rails, grebes, loons, cormorants, and gulls. Most birds within this group use the Refuge as feeding or resting grounds, with many departing the delta during the breeding season. Most of these birds also use the river, creeks, and sloughs within the study area south of the Refuge.

A few species, such as the great blue heron, feed and nest on the Refuge. The great blue heron hunts on the mudflats, salt marsh, and diked area, with principal foods consisting of fish, frogs, small mammals, insects, and crustaceans (Klotz et al. 1978). Great blue herons are found in all four units of the Refuge, but they are frequently seen feeding along McAllister Creek and the mudflats. The northwest bluffs of McAllister Creek provide habitat for a great blue heron colony (Thurston County Dept. of Water and Waste Management 1993). Herons were first observed nesting in this area in 1977 (1 nest). Nesting activity increased gradually to a high of 101 nests in 1994. Since then, nest counts have declined to 3 nests in 2001. This decline corresponds to the establishment of a nearby bald eagle nest. Predation by bald eagles appears to have influenced the movement of the nesting colony northward on the bluff, farther away from the bald eagle nest. The colony has also been abandoned during the chick rearing stage in recent years resulting in nesting failure. It is unknown whether eagle predation, human disturbance, or changes in the heron food resource are causing the decline in nesting birds and nesting failure. The great blue heron is a monitored and priority species in the State of Washington because of the increasing loss of foraging and breeding habitats as well as increasing environmental pollutants associated with human expansion and development.

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Great blue herons are common sightings on the Refuge throughout the year, but nesting success has declined in recent years.

Small numbers of American bitterns and Virginia rails are frequently observed on the Refuge in the spring and summer during nesting season (Ramsey 1997). Soras are less common but can be observed during spring and summer (Ramsey 1997). Sandhill cranes (3-4 at a time) have been observed infrequently in the inner diked area since 1983 (Ramsey 1997; USFWS data).

Western grebes are common migrants and winter residents. Pied-billed and horned grebes are common along McAllister Creek during winter and spring. Eared grebes can be observed occasionally on the Refuge. Fish are the primary food of western grebes. Other grebes feed on fish, crustaceans, insects, and mollusks.

Common and red-throated loons are commonly observed on the Refuge during the winter months. The common loon is considered a State candidate threatened species due to limited nesting locations and increasing human disturbances (Rodrick and Milner 1991). The yellow-billed loon, which is on the Birds of Conservation Concern (BCC) list (USFWS 2001), is an accidental vagrant to this area. Loons feed primarily on fish but do take other foods including crustaceans, mollusks, and insects.

Double-crested cormorants are commonly observed in McAllister Creek and the Nisqually River, or perched on driftwood or large snags in Unit 2. Gull species commonly observed on the Refuge include Bonaparte's gull, mew gull, ring-billed gull, California gull, and glaucous-

winged gull. Gulls, primarily fish eaters and scavengers, forage on the exposed and flooded mudflats in Unit 2 and the reach. Large numbers of gulls are due in part to the proximity of the Hawks Prairie Landfill, where some gull species feed. Closure of the landfill in 2000 has likely changed gull abundance on the Refuge since numbers have declined slightly. Caspian tern sightings are becoming more common on the Refuge since the establishment of a colony in nearby Commencement Bay in Tacoma. Although this colony was displaced in 2001, Caspian tern sightings are still common in the spring and summer. Common murres and rhinoceros auklets are infrequently observed in tidal waters during the winter months.

3.4.3 Shorebirds

Shorebirds (42 species which occur in the Pacific region [Alaska, British Columbia, Washington, Oregon, and California]) migrate long distances from breeding grounds in Alaska and Canada to wintering grounds in Central and South America. Habitats used by these shorebirds include coastal wetlands, freshwater lakes, seasonally flooded wetlands and grasslands, and saline-alkaline lakes. Only 30% of the original coastal wetlands remain in the Pacific region (Helmers 1992). Numerous interior wetland and estuarine areas have been lost to agriculture or industry.

Large numbers of shorebirds, up to 22 species, feed on the Refuge mudflats and salt marsh as they pass through during spring and fall migrations. Western sandpipers and dunlin, the predominant species, can be observed feeding on the exposed mud at low tides, concentrated in higher areas along the marsh, or in the inner diked area. Western sandpipers feed on annelid and nematode worms, arthropods, and other invertebrates, as well as salt marsh sandspurry seeds (Klotz et al. 1978). Greater yellowlegs, least sandpipers, killdeer, and common snipe are also commonly observed during the spring and summer. Other occasional sightings during this time of year include lesser yellowlegs, spotted sandpipers, semipalmated plovers, sanderlings, whimbrels, and dowitchers. A small number of common snipe and killdeer nest on the Refuge. A wintering population of dunlin has also been observed on the Refuge. An average of 480 birds (peak of 2,000 birds) have been observed during aerial winter waterfowl surveys; however, tidal conditions during surveys are often not conducive to high shorebird numbers. Black-bellied plovers are also occasionally seen on the tideflats in the winter months. On very rare occasions, marbled godwits and Wilson's phalaropes are seen

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Dunlins are common winter residents, often feeding on exposed mudflats.

3.4.4 Landbirds

Over 100 species of landbirds have been observed on the Refuge, including 22 species of raptors (owls, hawks, falcons, and eagles), 17 nonpasserines (e.g., woodpeckers, hummingbirds, kingfishers, doves, and pigeons), and 77 species of passerines (e.g., sparrows, finches, warblers,

flycatchers, and swallows). Landbirds found on the Refuge and study area include both residents and migrants. Long-distance migrants travel between breeding grounds in temperate North America and wintering grounds in Mexico, the Caribbean, and Central and South America. Short-distance migrants travel between wintering grounds north of the Mexican border and breeding grounds to the north. Resident species both breed and winter in the local area. Landbirds can be found in all habitats of the Refuge including riparian woodlands, agricultural lands, and freshwater wetlands.

In the 1980s, scientists observed a decline in numbers of migratory landbirds across the nation, apparently due to habitat loss and degradation both on breeding and wintering grounds. Nationwide efforts are now underway to identify more clearly the causes of these population declines, monitor populations of the most affected species, and reverse the declines, e.g., where possible through large- and small-scale land management efforts. Several species (e.g., olive-sided flycatcher, white-crowned sparrow, and pine siskin) on Nisqually NWR have been identified as "priority" species in this effort, and the Service is actively monitoring these populations.

3.4.4.1 Raptors

Raptors are found throughout all habitats of the Refuge. Some of the 22 species found on the Refuge are considered neotropical migrants because they spend their winters in South America. Northern harriers are the most regularly observed raptor, hunting over the salt marsh and non-native grasslands throughout the year. Other frequently observed species on the Refuge include bald eagles, peregrine falcons, red-tailed hawks, great-horned owls, and American kestrels. Greater species diversity and larger numbers are observed in the fall and winter months. Northern harriers, red-tailed hawks, American kestrels, and great-horned owls are known to nest on the Refuge. Barn owls have also been observed to nest in either one of the Twin Barns. Ospreys and merlins are observed occasionally on the Refuge. Ospreys feed exclusively on fish and are a State-monitored species that breeds along coasts, rivers, and lakes of coastal North America in the summer. Limiting factors include availability of snags, suitable live trees, or other suitable nest structures near large bodies of water that produce adequate fish supplies (Rodrick and Milner 1991). Northern goshawk, a BCC list species, is seen in the area on rare occasions.

Fall and spring migrating peregrine falcons are commonly observed hunting over the Refuge. They feed primarily on medium to small-sized birds such as pigeons, doves, shorebirds, waterfowl, and woodpeckers. Occasional sightings have been recorded from April through October. Peregrine falcons were recently taken off the Endangered Species List because their populations have rebounded. However, they are still listed as endangered by the State and are on the BCC list, and populations will be monitored for several years to ensure the population is stable or increasing. Falcons are observed most often hunting over the salt marsh and along the Nisqually River.

3.4.4.2 Nonpasserines

Common species in this group include rufous hummingbird, red-breasted sapsucker, downy woodpecker, belted kingfisher, and band-tailed pigeon. Hummingbirds arrive in late March and depart the Refuge by August. While downy woodpeckers are common, the Lewis' woodpecker

is an uncommonly seen BBC list species. Belted kingfishers are commonly observed along McAllister Creek and the salt marsh areas, with nesting pairs observed along McAllister Creek. Band-tailed pigeons are commonly observed on the Refuge and the East Bluff throughout March and April early in the breeding season. Primary food sources include cascara, elderberry, wild cherry, huckleberry, dogwood, and madrone (Rodrick and Milner 1991), all of which are found on the Refuge and study area. Rufous hummingbird and band-tailed pigeon populations have been declining in this region (Sauer et al. 2000).

3.4.4.3 Passerines

Most of the 81 species of passerines found on the Refuge are observed during the spring and summer months. Fifty passerine species are known to nest on the Refuge, including the American robin, cedar waxwing, common yellowthroat, song sparrow, red-winged blackbird, and 4 species of swallows. American goldfinches and savannah sparrows nest in open grassland areas. Many species migrate south after breeding (e.g., common yellowthroats and the swallows), but some remain on the Refuge throughout the year (e.g., black-capped chickadee, Bewick's wren, and American robin). Western meadowlarks winter on the Refuge and can be observed from September through December in areas adjacent to mowed fields. A few species on the BCC list include olive-sided flycatchers, white-crowned sparrows, and pine siskins that probably breed in the area; horned larks and golden-crowned kinglets that are seen during migration; and vesper and sage sparrows that are accidental visitors.

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Marsh wrens use a variety of habitats on the Refuge, including freshwater wetlands and salt marshes.

The salt marsh, freshwater, and brackish marsh habitats provide a year-round home for the marsh wren. Other passerines that feed on the salt marsh, often in large flocks, include the European starling, blackbirds, and finches. Crows commonly forage on the mudflats. Barn, cliff, violet-green, and tree swallows are commonly observed feeding on insects over estuarine habitats during spring and summer (Ulmschneider 1976).

The riparian woodlands along the Nisqually River on the Refuge and in the study area are a critical habitat for several breeding species with significantly declining region- or nation-wide population trends. These include the yellow warbler, willow flycatcher, downy woodpecker, and Swainson's thrush (Sauer et al. 2000).

3.4.5 Marine Mammals

Puget Sound has a rich diversity of marine mammals that either feed or breed in these waters. Some, such as the harbor seal, are year-round residents. Other species, such as the gray whale, may move into Puget Sound during their migration between wintering and breeding grounds. The harbor seal is the most abundant marine mammal observed in the Nisqually delta. Seals haul out on logs in the Nisqually River mouth or on flooded mudflats in the northeast area of the delta. They are also often observed swimming in the Nisqually River or McAllister Creek. In the 1940s, the delta was described as an important breeding ground for the harbor seal. Currently, no seals are known to breed on the delta, most likely because of human disturbance and harassment by boaters and other users of the delta (Klotz et al. 1978). Gray whales, minke whales, false killer whales, and orcas are occasionally sighted during the winter months in the Nisqually Reach. Sea otters are occasionally sighted in the Nisqually delta reach. California sea lion observations have increased in recent years, with a few sightings of the Federally threatened Steller sea lion.

3.4.6 Land Mammals

Forty-eight species of land mammals have been observed on the Refuge. Common large land mammals observed on the Refuge include Columbian black-tailed deer, coyote, river otter, long-tailed weasel, mink, eastern gray squirrels, raccoon, skunk, opossum, eastern cottontail, and beaver. All of these species probably occur in the study area as well. The eastern gray squirrel is an introduced species from the eastern United States that now commonly occurs in urban areas of the west. Observations of this species have been increasing on the Refuge in recent years. Native western gray squirrels have been observed in the study area near McAllister Creek and east of the Nisqually River (Thurston County Dept. of Water and Waste Management 1993; WDFW 2001). Western gray squirrels prefer oak woodland habitats, and it is unlikely that a population historically or currently occurs on the Refuge. Small mammal trapping conducted in 1977 and 1978 resulted in the identification of vagrant shrews, shrews, shrew moles, deer mice, Oregon voles, Townsend voles, and Pacific jumping mice on the Refuge (Klotz et al. 1978). Townsend's vole, deer mice, and vagrant and masked shrews were also found in grassland habitats, with Townsend's voles at the highest density (120.7/ha) (Bowman and Dobos 1976). Deer mice, on the other hand, are abundant in forested areas. Townsend voles and deer mice can also be found in salt marsh areas (Bowman and Dobos 1976). In addition, various species of bats have been observed on the Refuge, but there are little data on abundance and distribution.

3.4.7 Reptiles and Amphibians

Sixty-two species of amphibians and reptiles occur in the Pacific Northwest (Nussbaum et al. 1983), 13 of which have been observed on the Refuge. Red-legged frogs, Pacific tree frogs, and garter snakes inhabit open grassland and riparian areas of the Refuge (Klotz et al. 1978) and most likely occur in similar habitats in the study area. Long-toed salamanders, rough-skinned newts, and the introduced bullfrog are also found in emergent wetland, ponds, and woodland areas (Klotz et al. 1978). In recent years, northwestern and western red-backed salamanders have been observed on the Refuge.

The western pond turtle is listed by Washington State as an endangered species due to limited distribution, low numbers, and isolated populations. Historically, the Puget Sound lowlands were considered the northernmost limit of their range, but they were considered extirpated from this area and many other parts of Washington State by the 1980s (Hays et al. 1999). Western pond turtles spend much of their life in streams, ponds, lakes, and wetlands, but they also require terrestrial habitat for nesting, dispersal, dormancy during parts of the warmest months, and overwintering (Hays et al. 1999). The Refuge has suitable habitat for western pond turtles; however, none have been seen in recent years. In 1991, a western pond turtle was found near McAllister Creek under highway I-5 (Thurston County Dept. of Water and Waste Management 1993). The turtle was released within the Refuge, but after 2 weeks it was not seen again. No western pond turtles were found during extensive surveys in the Fort Lewis area (Cassidy et al. 1997).

The Oregon spotted frog, recently differentiated from the closely related Columbia spotted frog, is listed in Washington State as an endangered species and is also a candidate species under the Federal Endangered Species Act. The frog's limited number of existing populations and lack of protection for these populations warrants State and Federal protection (McAllister and Leonard 1997). While Oregon spotted frogs have a wide variety of predators, they are particularly vulnerable to introduced species including bullfrogs and numerous warmwater fishes. Oregon spotted frogs require freshwater emergent wetlands, which were historically found in the floodplains of many larger bodies of water. Much of this habitat has been drained, filled, diked, or degraded due to exotic plants like reed canary grass (McAllister and Leonard 1997). The Nisqually NWR has appropriate Oregon spotted frog habitat, but there are no known populations occurring on the Refuge or in the area.

3.4.8 Invertebrates

Many of the organisms found within estuaries depend on small marine invertebrates as a food resource. The marine invertebrate community in the Nisqually delta has been minimally studied in the past. A survey conducted in 1978 (Wisseman et al. 1978) found an abundance of ghost shrimp, bivalves, polychaetes, spionids, and nematodes in mudflats in the RNA portion of the Refuge. Polychaete assemblages found in cobble and mixed sediment areas contrasted sharply with those found in muddy areas. Small crustacea (tanaid and cumacean) and numerous amphipod species were found in sediment surfaces in high numbers. Bivalves were the most abundant species found in the mudflats between the Nisqually River and McAllister Creek. This area also contained gastropods and opisthobranchs at lower tide levels as well as amphipods, which were abundant in the sandy flats. Geoducks were found occasionally, low in the intertidal along the delta front (Wisseman et al. 1978).

Terrestrial invertebrates are also very important to the wildlife community. No complete inventory has been conducted on the Refuge or study area. In 1992, a specimen collection was prepared for educational purposes. It included 82 specimens from nine families, ranging from damselflies and grasshoppers to wasps and bees (USFWS data). During the summer of 1994, a butterfly study detected 47 different species of butterflies on the Refuge (USFWS data).

3.4.9 Invasive and Exotic Wildlife Species

European starlings are abundant on the Refuge during the nesting season and winter months. Their early nesting behavior has eliminated many cavities for wood ducks, American kestrels, and swallows. Non-native bullfrogs are a threat to native amphibians because they prey on juveniles and adults. Competition between larval bullfrogs and larvae of native amphibians may also be a factor in the decline of native species. Mitten crabs and green crabs are aquatic nuisance species that are rapidly spreading in coastal Washington, but they have not yet been found on the Refuge or elsewhere in south Puget Sound (K. Aitkin, pers. comm.). Monitoring programs are being designed to ensure early detection of these invasive species.

3.4.10 Federally Endangered and Threatened Species

The Federally threatened bald eagle, marbled murrelet, and Steller sea lion, and endangered brown pelican occur on Nisqually NWR. Of these species, the bald eagle is most commonly observed. Wintering bald eagles are observed feeding and resting on the Refuge from October through March. A peak count of over 25 individuals has been observed feeding on the Refuge tideflats, whereas as many as 200 have been observed on the Nisqually River (Stalmaster 2001). Bald eagles are scavengers but also hunt for fish and birds. Nesting activity occurs from February through mid-July. A pair of eagles has used the same nest site along the western bluff of McAllister Creek every year since 1992. This breeding pair has fledged two healthy chicks every year, with the exception of 1997. Three other breeding pairs have been identified within the vicinity of the Refuge, including one in the study area on the eastern bank of the Nisqually River south of I-5. These birds most likely use the Refuge as feeding grounds. Eagles depend on dead or weakened prey such as fish, waterfowl, seabirds, and small mammals (Rodrick and Milner 1991).

Brown pelicans have been observed occasionally in the Nisqually Reach. Marbled murrelets have been observed in or heard flying over the Nisqually Reach. The Nisqually Reach probably serves as important feeding grounds for much of the south Puget Sound population (B. Ritchie, pers. comm.). Murrelets probably travel from the reach through the study area, using the Nisqually River corridor, to unidentified nesting locations in forested upland areas. The WDFW considers all of Thurston County potential marbled murrelet habitat (Thurston County Dept. of Water and Waste Management 1993).

The Steller sea lion is observed occasionally in the Nisqually Reach.

The National Oceanic and Atmospheric Administration Fisheries is the Federal agency responsible for Federally listing most marine life as threatened or endangered, including fish. Federally listed fish species are discussed in Sections 3.3.1 (Pacific Salmon) and 3.3.4 (Threatened and Endangered Fish).

3.4.11 State Listed Species

There are several Washington State listed species that are discussed in previous sections. These include the endangered western pond turtle, Oregon spotted frog, brown pelican, and sandhill crane. Washington State threatened species include the Steller sea lion, bald eagle, and marbled

murrelet. Among the Washington State candidates for listing or species of concern, 11 species are either known to occur or potentially occur on the Refuge. These are Townsend's big-eared bat, common loon, western grebe, Brandt's cormorant, northern goshawk, merlin, common murre, pileated woodpecker, Lewis' woodpecker, willow flycatcher, and purple martin.

3.5 Special Uses

3.5.1 Haying

Since 1974, permittee(s) have hayed the non-native grasslands on the Refuge in late summer to provide fall browse for migrating waterfowl, primarily American wigeon. The total acreage hayed varies from year to year with each permittee and depending on rainfall. Acreage cut has ranged from 100 to 312 acres. Currently, approximately 250 acres of non-native grassland are cut once from July 1 through September 30. Haying is delayed until July to maximize survival of any ground-nesting birds. The permittee pays a percentage per ton of hay cut.

3.5.2 Scientific Research

It is Service policy to encourage and support research and management studies to provide scientific data upon which decisions regarding management of units of the Refuge System may be based. Priority is granted to studies that contribute to the enhancement, protection, use, preservation, and management of native wildlife populations and their habitats in their natural diversity. All special use permits issued for research specify that they be conducted in a manner to cause minimal effects on wildlife and habitat. The Refuge is occasionally used for various research projects addressing vegetation, habitat, bird, small mammal, and other resources.

3.5.3 Tribal Fishing

Tribal fishing by members of the Nisqually Indian Tribe occurs in McAllister Creek and the Nisqually River. The fishing is provided for in the Treaty of Medicine Creek of 1854 (10 Stat. 1132). The Nisqually Indian Tribe fishes in McAllister Creek, the Nisqually River, and adjacent marine waters, using set nets or other traditional methods, or with modern, improved fishing techniques without curtailment of the right of access to these fishing areas. Tribal fishing is conducted by power boat in both the creek and the river with set nets. The commercial tribal fishery occasionally causes unintentional take of non-target species such as harbor seals or diving birds.

3.6 Public Access, Education, and Recreational Opportunities

This section describes the public access, education, and recreation opportunities at the Nisqually NWR. Recreation features and access points on the Refuge are shown in Figure 3.6-1.

3.6.1 Public Access

The Refuge is open daily during daylight hours. The main access point is by road at Exit 114 off I-5. In addition, visitors access the Refuge by boat. Most boaters launch from the State-owned Luhr Beach boat ramp at the northwest corner of the Refuge. The Refuge has a daily entrance fee of $3.00 per family. The Golden Eagle, Golden Age, Golden Access Passports; Refuge Annual Pass; and Federal Duck Stamp also admit one family. Children under 16 are free. The entrance fee is waived for educational groups studying nature as part of a course of curriculum. Visitors pay the entrance fee at a fee station at the entrance to the Visitor Center.

The Visitor Center and its parking area is the primary destination for Refuge visitors. A paved ½- mile access road located within the Refuge boundary brings visitors to the Refuge Visitor Center, trailheads, and its 100-car parking lot. The entrance road provides access for cars and school buses with occasional bicycle use. Bicycle racks are provided at the Visitor Center. A city bus does not serve the Refuge at this time although the Refuge supports this possibility. Recent upgrading and improvements to the entrance and parking lot are adequate for the life of this plan other than expected routine maintenance.

Refuge lands east of the Nisqually River are currently closed but can potentially be accessed via Mounts Road, Exit No. 116. No public parking currently exists on the east side. A narrow road/underpass under the main line of the Burlington Northern Santa Fe Railway (BNSF) provides road access but is narrow and may present vehicle size limitations and safety concerns.

The only public access points within the study area are outside of the Refuge boundary located on WDFW and Fort Lewis lands for bank fishing access on the Nisqually River. Existing parking capacity at the State-owned Luhr Beach is approximately 30 vehicles. Visitors park loosely in an area that is a combination of gravel and hard surface. South of I-5 in the study area, vehicles associated with fishing park unofficially within the Trotters Woods unit of the Fort Lewis Military Reservation. No estimate of capacity is given for this area because of the highly dispersed parking and disturbed nature of this site.

Other potential public access points within the study area include a WDFW bank fishing site with some parking capacity on the west bank of the Nisqually River. Also, potential access and parking in the study area include the closed State fish hatchery site and the City of Olympia McAllister Springs site.

3.6.2 Recreation

3.6.2.1 Wildlife-Dependent Recreation

More than 100,000 people per year visit the Refuge to participate in a variety of wildlife-dependent recreational and educational activities. These include wildlife observation and photography, interpretation, environmental education, and fishing. A 7-mile trail system, Visitor Center, Environmental Education Center, designated bank fishing access, and photoblinds support these activities.

D.S. Pitkin

More than 100,000 people visit the Refuge annually to participate in wildlife observation, interpretation, photography, fishing, and environmental education.

Wildlife Observation and Photography

Although wildlife observation and photography are good year round at the Refuge, the best times for wildlife viewing are fall, winter, and spring. The Refuge's location, with its wildlife diversity and mosaic of habitats and trail access to those habitats, makes it a popular place for birdwatchers; Nisqually NWR is considered by many to be one of the best birding areas in Puget Sound.

The Refuge's 7 miles of trails include a 5½-mile loop trail and a 1-mile loop trail for walking only. Bikes, jogging, and pets are not allowed on the Refuge. Wildlife observation is also conducted by Refuge visitors entering the Refuge by canoe or kayak.

The Brown Farm Dike Trail is a 5½-mile loop in which all major habitats on the Refuge can be viewed. The trail is on the dike and is flat, wide, and easy to walk. Along the trail are benches, an observation tower, two photoblinds, and two short spurs, a ½-mile Ring Dike Trail and the McAllister Creek bank fishing area**.** The Brown Farm Dike Trail is a popular trail for hikers and birdwatchers; because of its length, ease of walking, and access to many habitats, it is unique in the area. Visitors spend anywhere from 2-6 hours on this trail. On any given day, birdwatchers can tally upwards of 60 different bird species seen along this trail.

From early October to mid-January, 3 miles of the Brown Farm Dike Trail (between the Ring Dike and McAllister Creek) are closed during the waterfowl hunting season; specific dates vary from year to year. The trail is closed because waterfowl hunting is allowed on WDFW inholdings that are adjacent to large portions of the trail. The trail closure provides a dual purpose: to ensure safety for trail users and provide wildlife sanctuary. Waterfowl benefit by being able to move into the closed diked interior undisturbed by trail users when the trail is closed. This annual trail closure negatively affects large numbers of Refuge visitors unable to access certain areas of the Refuge during fall and winter. It is the single largest conflict among visitors within the Refuge boundary. Although the trail is closed with a gate and signs explain the closure, trespassing regularly occurs.

Figure 3.6-1. Current authorized public recreation within the study area.

Figure 3.6-1
back side

The Twin Barns Loop Trail is a 1-mile long boardwalk trail, which is fully accessible to people with disabilities. Along the trail, visitors pass through riparian habitat, freshwater wetlands, and grasslands. Habitat restoration along the 1-mile boardwalk trail has improved wildlife observation opportunities. At various locations along the trail, there are benches, viewing decks, scopes, and interpretive panels. SaniCans and trash receptacles are located at the northern end of the trail. Here, the trail also extends to include an elevated viewing platform with four different levels, scopes, and benches. Two short spur trails offer views of the Nisqually River and surge plain habitat. This trail is used by education groups and visitors who have less time to spend at the Refuge or want a shorter walk.

Interpretation

A new 4,800-square foot Visitor Center was opened to the public in fall of 1999. The Visitor Center has an interpretive exhibit room with displays that focus on the Nisqually River watershed, the Pacific Flyway and migratory birds, and the Nisqually River Estuary and delta. A 100-person auditorium, with full audiovisual capacity, is used for special events, lectures, and training sessions. The auditorium also has a rotating wildlife art exhibit.

The Visitor Center is open Wednesday through Sunday, 9:00 a.m. to 4:00 p.m. Trained Refuge volunteers staff the information desk, answering questions, handing out brochures, and selling entrance passes and items from the cooperating association sales outlet. The Friends of Nisqually National Wildlife Refuge operate the sales outlet and helps support Refuge programs. Refuge staff are on-site at all times.

J. Takekawa

The Refuge visitor center and administrative headquarters include exhibits that focus on the watershed, estuary, and migratory birds in the Pacific Flyway.

Refuge staff and volunteers conduct special events throughout the year to help people learn more about Nisqually's fish and wildlife resources. These events include International Migratory Bird Day, a Summer Lecture Series, National Wildlife Refuge Week, and the Nisqually Watershed Festival. The Twin Barns Loop Trail has interpretive panels at a number of locations that focus on the habitats and wildlife along the trail.

A private non-profit organization operates the Nisqually Reach Nature Center at Luhr Beach on WDFW land. The center is open to the public 2 days a week and has a variety of interpretive displays on the various fish and wildlife dependent on the marine waters of the Nisqually delta.

Fishing

The Refuge offers fishing opportunities for salmon, steelhead, and trout in McAllister Creek and the Nisqually River, and for shellfish and bottomfish in the tideflats. All State fishing regulations are in effect. No fishing is allowed inside the dike. The Refuge estimates that 3,800 visitors fish at the Refuge each year, but the number is difficult to verify as no counting system is in place. Some fishing occurs within the RNA in the northeast part of the Refuge. This is considered an administratively uncontrollable area as the RNA is not signed.

Most anglers access the Refuge by boat from Luhr Beach. Bank fishing is permitted only in the designated McAllister Creek bank fishing area, located on the east side of the creek and accessible from the Brown Farm Dike Trail. Anglers must walk 3/4 of a mile to access the bank fishing area. Persistent and numerous illegal entries occur from anglers entering this area at the southern boundary of the Refuge near the I-5 ramp. WDFW has recently proposed to close the McAllister Creek Hatchery; if this occurs, fishing opportunity in McAllister Creek would decline dramatically.

In 1996, due to loss of trails, river bank, and bank instability, the bank fishing area along the Nisqually River was closed. Currently, there is no Refuge bank fishing access along the Nisqually River although several points of illegal entry exist and are used by anglers. Two bank fishing sites on the Nisqually River that are open to the public are located south of I-5 and within the study area. This includes a State-managed site on the west bank of the river and a site on Fort Lewis property on the east bank. The State site is owned and managed by WDFW and provides parking, bathrooms, and accessible bank fishing. However, changes in the river have made this site less usable for anglers with disabilities. The Fort Lewis site is open to the public with minimum management. The public is allowed to drive through riparian habitat down to the river bank. A variety of dirt roads have been created from this off-road driving activity. There are no restroom facilities on-site.

In 1992, the Washington State Department of Health reclassified 2,130 acres of commercial and recreational shellfish beds in Nisqually reach from “approved” to “conditionally open” after finding elevated levels of fecal coliform bacteria in the reach following storm events (Whiley and Walter 1996; Emmett 1995). Following further evaluation, the shellfish beds in the vicinity of Luhr Beach were closed to harvest in spring 2000 (W. Clifford, pers. comm.). Prior to these closures, recreational shellfishers accessed the tideflats by foot from Luhr Beach during spring and summer low tides to collect shellfish including littleneck, butter, and horse clams, crab, and geoduck. Dungeness crab is also harvested with pots in deeper water. Dungeness crab harvest is not affected by the Luhr Beach closure. Signs notifying the public of the shellfishing closure and health hazards are posted at Luhr Beach, and compliance is entirely voluntary. No enforcement is conducted and violations do occur. Shellfishing activity at Luhr Beach creates trespass problems on the Refuge tideflats and shoreline by attracting other visitors onto the tideflats. Dog and beach walkers enter the area illegally during low tides.

Hunting

Currently, the only authorized public waterfowl hunting that occurs within the delta is on State WDFW tidelands. Refuge lands are not open to hunting. The Nisqually NWR Conceptual Plan

(CH2M Hill et al. 1978) proposed a quality waterfowl hunting program in the Nisqually tideflats area and on land east of the Nisqually River. This program has never been implemented because the Service has not been able to come to an agreement with the State on the hunting program design. In addition, the Refuge has been unsuccessful in acquiring the inholdings east of the Nisqually River. Because the Refuge and WDFW lands are not adequately posted, waterfowl hunting does occur on some Refuge tidelands (up to 1,189 acres) that are administratively uncontrollable.

Refuge staff and volunteers have been monitoring waterfowl harvest activities associated with State lands in the Nisqually delta almost annually since 1981. Prior to 1998, monitoring efforts consisted of sporadic hunter bag checks, conducted at Luhr Beach boat ramp, varying in effort from year to year. Analysis of the 1990-1997 data set showed that the annual number of ducks harvested per hunter visit ranged from 1.5 to 1.9 ducks/hunter visit. The number of geese harvested ranged from 0.0 to 0.2 geese/hunter visit. Between 1991 and 1997, annual hunter visits ranged from 11 visits/day in 1997 to 31 visits/day in 1991 and 1994. The vast majority of ducks harvested were dabblers, primarily American wigeon, mallards, and green-winged teal. American wigeon comprised 51% of the total duck harvest over all years. Fifty-five percent of hunter visits occurred in the area known as Survey Unit 2, the Nisqually tideflats area (Figure 3.4-1) (Seto 1998).

In October 1998, an intensive hunter bag check project was initiated to better document and understand hunting activity on the delta. All hunting activities occurring on weekend days, holidays, and 41% of weekdays were monitored throughout the waterfowl hunting season. The results of this monitoring effort showed similar results in terms of species harvest with wigeon, teal, and mallard comprising over 80% of the harvest. Hunter success averaged 1.5 birds/hunter visit over the season. There were an estimated 1,000 to 1,200 hunter visits during the entire season. Hunter visits were four times higher on weekends, averaging 20.5 hunters visiting each weekend day, and only 5.2 hunters per weekday. The level of hunting activity was relatively stable throughout the season, with only a slight decrease in activity after mid-November. No information was collected to map the distribution of hunters throughout the area (Seto 1999).

Some private hunting (Medicine Creek Hunt Club) occurs on property south of I-5 in the study area, although use levels are believed to be low. Waterfowl hunting also occurs in the Trotter's Woods area by approximately 3-4 hunters.

3.6.2.2 Non-Wildlife Dependent Recreation Activities

Non-wildlife dependent recreational activities that occur on the Refuge include boating, PWC use, and fruit and berry picking.

Boating

Both motorized and non-motorized recreational boating occur in all waters of the Refuge outside the Brown Farm Dike. Some of these activities are wildlife-dependent and are addressed above. The majority of boaters access the area from Luhr Beach. Commercial rafting, canoe, and kayak tours use the waters of the Refuge on a year-round basis. No boating is allowed inside the Brown Farm Dike. Boating occurs within the RNA in the northeast portion of the Refuge.

It is estimated that 6,700 boaters access the Refuge annually, although this number is difficult to verify as no counting system is in place. Recreational boating has increased dramatically and is expected to continue to increase in concert with residential development underway on adjacent lands. Luhr Beach is one of the few launch sites in the area with access to Puget Sound.

There is no boat speed limit for motorized craft in open waters, except for Thurston County's Shoreline Protection regulation that limits speeds of motorized watercraft to 5 mph within 200 feet of shoreline (Thurston County Regulations, Title 16, Waterways and Vessels [16.04.110]). A compatibility determination completed in 1994 stipulated several restrictions that have not been put in place, including: a posted no-wake zone, area and seasonal closures on the tideflats, regulations information in brochures and at Luhr Beach, and closure of most of the water of McAllister Creek year round.

PWC Use

PWC use occurs on the Refuge, mostly along McAllister Creek and in the reach, with users typically launching from Luhr Beach. There are no good estimates as to the amount of PWC use that occurs. Several complaints have been received from trail users about the disturbance caused by PWC activity related to noise and wildlife disturbance.

Fruit and Berry Picking

During the historical farming period, an apple and pear orchard was planted in what has now become the maintenance compound and adjacent areas. The Service does not routinely maintain the orchard trees, and the trees produce a large crop of fruit each year. Visitors are allowed to pick up windfall fruit or pick fruit off the trees that they can reach from the ground. No climbing of the trees or knocking down of fruit is allowed.

Visitors are also allowed to pick small amounts of blackberries that grow profusely in thickets along the Refuge trails and parking lot. The harvest of both fruit and berries is for personal use only; no picking for commercial use is allowed. Blackberry picking occurs during August and September, while the harvest of orchard fruit occurs from September through November.

Most picking of fruit and berries is done along the trails by small groups of visitors that are at the Refuge to walk and observe wildlife. However, off-trail berry picking and picking of large quantities of fruit and berries do occur, creating a trespassing problem and oversight problem for Refuge staff.

3.6.3 Environmental Education

Since the establishment of the Refuge, educators and youth professionals have been using Nisqually NWR as an outdoor classroom to enhance course curricula. The Refuge's environmental education program serves educators and youth professionals who work with pre-school through college-age youth. Educators include teachers, professors, and outdoor education leaders. Youth professionals include leaders for Scouts, 4H, and Campfire.

Each year, approximately 5,000 students and teachers from King, Pierce, Thurston, and Mason counties participate in the Refuge's environmental education program. Although educational groups use the Refuge throughout the year, the highest use period is from early April through mid-June. Summer use has increased dramatically in the past several years.

Environmental education field trips at Nisqually NWR are teacher-led. Due to limited Refuge staff availability, teachers and group leaders are expected to plan and lead their own field trip activities with minimal assistance from Refuge staff. It is recommended that teachers visit the Refuge prior to their field trip, walk the trail, and prepare clearly defined field trip goals and objectives. The Refuge offers lesson-planning assistance to teachers and orientation talks to school groups while at the Refuge. Approximately eight volunteers work with 90% of the school groups visiting the Refuge. Volunteers provide an orientation talk and may walk with groups along the trails. They also talk with the teachers prior to their trip about their goals and activities. Since November 2000, an Environmental Education Intern has been hired through the Washington Conservation Corps AmeriCorps program. This full-time position helps improve and facilitate the education program. Plans are to recruit and fill this position each year as funding allows.

Prior to visiting, educational groups are required to make a reservation indicating pre-trip activities, goals, field trip activities, locations and times, and what assistance they would like from the Refuge. If the educational group is coming as part of a course of curriculum to study nature, the entrance fee is waived. Education groups visiting the Refuge are limited to 100 students per day. Groups are only allowed on the trails, the Environmental Education Center, Visitor Center, and currently in three designated environmental education (EE) study sites. They may not collect samples or go off trail unless allowed through a special use permit.

The Refuge provides an ideal setting to reach a diversity of students and teachers.

The Twin Barns Education Center was severely damaged and closed following the 2001 Nisqually Earthquake. The Environmental Education Center has been temporarily moved to a trailer near the maintenance compound. A replacement facility is required to upgrade facilities and ensure a safe, quality experience for school children participating in the program.

The only other education center within the Refuge or study area is located at Luhr Beach. The private, non-profit Nisqually Reach Nature Center doubles as a wildlife interpretation center and an educational center for school children ranging from 3rd to 12th grades. The educational focus at the Nature Center is on the marine environment. They have supported up to 2,000 students per year. In 2000, the Refuge provided half the cost to fund an AmeriCorps intern to enhance the program as part of a growing partnership with the Nature Center.

3.7 Cultural Resources

3.7.1 Native American Cultural History and Landscape

From 13,500 to 8,000 years ago, aboriginal peoples may have used the delta estuary as a travel corridor between the sound, upland prairies (which were more prevalent at that time), and the glacial Lake Nisqually drainage channels (Forsman et al. 1998).

Aboriginal people were known to have a village at the mouth of the Nisqually River about 5,000 years ago (Stevenson 1998). During and since 3,000 years ago, winter and seasonal camps for foraging were maintained on the Nisqually River. Winter villages and camps have also been recorded at several locations along the lower reach of the Nisqually River.

The Nisqually Indians lived along the Nisqually River and its tributaries in numerous small villages. Permanent villages were noted for their cedar planked houses, while seasonal camps on the delta were characterized by temporary shelters. The variety of ecozones–prairies, woods, and the delta estuary–provided rich resources for fishing, hunting, and gathering activities. Coho, king, sockeye, chum, and pink salmon constituted a major part of their diet. Shellfish (clams, oysters, geoducks, mussels, and barnacles) were gathered along the shores of the river. Small and large game (deer, bear, and beaver) and waterfowl were also hunted. The delta and river basin supplied abundant plant resources for food, medicine, basketry, and other technological needs. The open prairies were used for social gatherings and ceremonies (Forsman et al. 1998).

The Refuge is the site of the signing of the first Indian treaty in Washington Territory. In December 1854, at a grove of trees along the east bank of McAllister Creek now known as the Treaty Trees, representatives of southern Puget Sound tribes met with Territorial Governor Isaac Stevens to negotiate and sign the Medicine Creek Treaty. Through the treaty, Indian tribes relinquished rights to the land and agreed to relocate to certain reservations. The Nisqually Indians received a reservation along the Nisqually River 5 miles upstream from the delta. In 1918, the 3,300-acre holding in Pierce County was condemned to establish Fort Lewis. The Nisqually Tribal reservation currently includes 1,400 acres in Thurston County (Thurston Regional Planning Council 1997). The treaty reserved certain fishing, hunting, and gathering rights for the tribes. Members of the Nisqually Indian Tribe still exercise these treaty rights, fishing for salmon in Refuge waters (G. Walter, pers. comm.).

3.7.1.1 Archaeological Resources

Twelve recorded archaeological sites are located within the existing boundary of the Refuge. Prehistoric sites occur primarily along the west bank of McAllister (previously known as She-Nah-Num or Medicine) Creek and in various locations along the adjacent bluffs. Historical sites are found predominantly in the south-central portion of the Refuge. Of the 12 sites, six fall within the boundaries of the waterways managed by WDFW.

One prehistoric site, known ethnographically as She-Nah-Num and archaeologically as the Medicine Creek Site, was determined eligible to the National Register of Historic Places (NRHP)

in 1977. A nomination was prepared but never submitted, however, so its status remains "eligible." It is one of the six sites outside Service jurisdiction. The site contains both prehistoric (shell, fire-cracked rock, bone, and lithics) and historical (bricks and bottles) elements. A shell midden site located on the McAllister Rod and Gun Club, which also contains an historical component, was determined ineligible to the NRHP. The remaining six prehistoric sites are all characterized as shell concentrations suffering from various degrees of tidal erosion.

Eighteen additional recorded cultural resources are located within the boundaries of the study area. Among the most significant of these resources is a shell midden with both prehistoric and historical components, which is identified as the probable home site of Sinnaywak, a noted Nisqually leader and shaman who lived from 1814-1904. Radiocarbon dating on another prehistoric midden deposit in the study area has returned occupation dates between 5,000 and 1,300 years ago, making it one of the oldest shell midden sites known in the southern Puget Sound area. A third shell midden site occurs in the study area but has received no in-depth archaeological research.

3.7.2 Euro-American Cultural History

In 1833, the Hudson's Bay Company established a trading post and farm in the Nisqually River delta. Soon after, Euro-Americans began to settle in the area, attracted by the proximity to water and the large, unforested tracts of land. By 1839, the character of the Nisqually Valley began to change as a major part of the economy shifted from fur trading to raising sheep and agricultural pursuits. In 1845, the McAllister family settled on Medicine Creek, now McAllister Creek. By 1852, James McAllister had dammed McAllister Creek and built a sawmill which produced some of the first lumber to be exported from Puget Sound to San Francisco (Stevenson 1998; Guth 1998). Other early settlers included the Shazer family, William Packwood, and Joel Myers. Land survey maps of 1853 described the area around McAllister Creek as "rolling hills and burnt timber" (United States Surveyor General 1853).

North of present-day I-5 on the southeast corner of current Refuge lands, low-lying upland areas along the Nisqually River were cultivated by homesteaders such as the Shazers and Myers. During the late 1800s, many estuarine habitats were lost, including parts of the Nisqually River Estuary, as pioneers throughout the Puget Sound diked and drained deltas for agriculture. George Shannon acquired the Shazer property, located north of I-5 on the Refuge, in 1872. He began to dike the property to grow grain and hay, raise cattle and horses, and develop private hunting and fishing areas. Delta lands east of the river were purchased and diked in the late 1890s by Ollie Braget (Stevenson 1998). Ditches, dikes, and fence remnants on the tidelands seaward of the main dike found today indicate past use of some marsh areas. Old pilings and cable in the surge plain forest suggest past logging activities (Kunze 1984).

In 1904, Alson L. Brown and his wife purchased about 2,350 acres of the Nisqually River Estuary west of the mouth of the Nisqually River and along the McAllister Creek hillside. Brown constructed the original 4-mile dike which is now a prominent feature of the Refuge. The dike, which altered the hydrologic regime of the delta, was built using a horse-drawn scoop and a crew of 30 men. In 1910, the dike was reinforced by a dredge that filled in the remaining sloughs. The fertile river delta soils were converted to crop production. The farm also maintained chickens,

hogs, a dairy operation, shipping operations, and a general store. The foundations of various buildings, most probably associated with the A.L. Brown Farm, are scattered around the delta. In addition, the apple orchard adjacent to the Refuge headquarters is also a remnant of the farm's early years. Structural and landscape elements associated with the Brown Farm are eligible to the NRHP. Although Brown went bankrupt after WWI, the farm continued to operate under the subsequent owners who rebuilt the dike, higher than the first, and built the Twin Barns in 1932. These barns were determined to be ineligible to the NRHP in the 1970s.

Historical sites within the study area, but outside of the approved Refuge boundary, include examples of residential complexes, civil infrastructure, and structures associated with various organizations. Seven homestead locations were recorded, with settlement dates ranging from the 1870s to the 1940s. In some instances, a collapsed building or foundation marked the site of a structure at the time of recording, but in most cases the presence of fruit trees, clearings, and other landscape features was the only evidence remaining. Since these sites were first recorded in the late 1970s and 80s, it is likely that further deterioration or complete obliteration has occurred. At least two of the homestead sites occur on land originally allotted to Nisqually Indian Tribal members. While most of the sites have not been evaluated, two of the homesteads have been determined ineligible to the NRHP.

Other historical structures recorded within the study area include: the Indian Agency Headquarters dating to 1859, an old Boy Scout Camp structure, a gas station, and a structure of unknown function which may have been constructed and utilized by the U.S. Army. Of the four, both the Boy Scout Camp structure and gas station have been determined ineligible, and the others have not been evaluated. Foundations of four historic bridges and/or trestles, two of which date from the 1930s, have also been recorded. At least two of the bridges have been completely destroyed.

3.8 Socioeconomics

This section provides an overview of the local demographic, land use, and economic setting in the vicinity of the Nisqually River delta and watershed, with emphasis on issues specific to inform comprehensive conservation planning efforts. The study area includes the lower Nisqually River Valley, including the delta. Socioeconomic data for both Pierce and Thurston counties are cited in this section.

3.8.1 Socioeconomic Setting

Nisqually NWR is located in south Puget Sound, straddling the Pierce and Thurston County border and within easy driving distance of approximately 4 million residents. The Seattle metropolitan area is the largest population concentration nearby, located roughly 50 miles to the northeast. Other large populations reside in the vicinity of Tacoma, 20 miles to the northeast, and Olympia, 10 miles to the west. All of these urban areas are provided an easy access to the Refuge via I-5.

Government provides the greatest share of employment in the vicinity of the Refuge. Olympia, the State Capitol, is the nearest major employment center to the Refuge. Fort Lewis, a major Army installation, is located adjacent to and northeast of the Refuge. The major private sector employers in Thurston County include St. Peter Hospital, Capital Medical Center, Group Health, Crown Cork & Seal, Miller Brewing Company, and CNC Corporation (Thurston County Economic Development Council 2001). The nearest major Pierce County employers are Intel and State Farm Insurance, both located in the nearby City of DuPont.

3.8.1.1 Population and Demographics

The population of Washington State has grown by 1.3 million since 1985, from 4.7 million to 6 million residents in 1999. Forecasters expect this figure to rise to approximately 6.5 million by the year 2005 (Office of Financial Management [OFM] 2001). The Puget Sound region, consisting of Pierce, Kitsap, King, and Snohomish counties, contains the largest population concentration in the state, with an estimated 1999 population of 3,125,200. This figure has increased by 441,130 new residents since 1990, an annual average increase of 1.8% (Thurston County Regional Planning Council 2000; Puget Sound Regional Council [PSRC] 2000). Consistent with regional trends, urban growth and resulting population pressures in the area surrounding the Refuge have expanded dramatically over the last 50 years.

The population of the Puget Sound region is expected to grow by 30% in the next 15 years (White 1997). Table 3.8-1 shows the 1999 estimated population and growth projections for the areas surrounding Nisqually NWR, including both Thurston and Pierce counties and the nearest local communities of Lacey (including Hawks Prairie) to the west and DuPont to the east.

Table 3.8-1. Local Population Trends.

Locality	Estimated population 1999	Anticipated Population, 2020	Percent Growth
Thurston County	**202,700*** **	**296734**	**46**
Olympia	40,210**	54020	34
Lacey	29,020**	45760	57
Hawks Prairie	3000	12250	398
Pierce County	**700,000****	**848610**	**23**
Lakewood	63,790*	81,290****	27
Tacoma	187,200*	249,000*****	33
City of DuPont	1,755***	No Estimate	Unknown
Fort Lewis Military Reservation and McChord AFB	46438	No Estimate	Unknown

Sources: *PSRC (2000)
**Thurston County (2001)
***OFM (2000)
****City of Lakewood 2000 (Note: projection for 2017 not 2020)
*****GLUP, Adopted 12/11/2001 P. 58, Pers. Comm, Dana Brown, Urban Planner, City of Tacoma (Note: projection for 2017 not 2020)

Thurston County

Thurston County has consistently exceeded the State's overall rate of growth since the 1960s and remains one of the fastest-growing counties in the state. Thurston County's 2000 population was estimated to be 204,300, having increased on average by 2.4% per year since 1990 (Thurston Regional Planning Council 2000), representing a 27% growth between 1990 and 1999 (DoA 2002). Thurston County's population is split between incorporated jurisdictions and unincorporated areas of the county. The county's seven incorporated cities have a combined population of 88,950, while the remaining (unincorporated) parts of the county have 115,350 residents. Lacey, the second largest city in the county with an estimated 2000 population of 29,240, lies to the west of Nisqually NWR. Since 1990, Lacey has averaged the fastest population growth rate of any large community in the county at 4.3% (Thurston Regional Planning Council 2000).

The community of Hawks Prairie, a portion of the City of Lacey located largely within the McAllister Creek basin to the west of Nisqually NWR, had a 1999 estimated population of 3,000. The population within Hawks Prairie is estimated to climb significantly to 12,250 by the year 2020 (V. Tabbutt, pers. comm.).

In 1997, Caucasians made up about 90% of the county's population, with 5.5% of the population comprised of Asians and Pacific Islanders. The African American population constitutes 2.5% of Thurston County, and the Indian/Eskimo/Aleut population is less than 2% of the Thurston County population (Thurston Regional Planning Council 1998).

Pierce County

Pierce County is the second-most populated county in Washington State (Thurston Regional Planning Council 2000). In 1990, 57% of the county's population lived in unincorporated areas (Pierce County Public Works and Utilities 1997). Pierce County's 1999 population was estimated at approximately 700,000 residents. This number is forecasted to grow by 21% over the next two decades to reach approximately 848,610 by 2020 population (National Association of Counties 2000).

The cities of Tacoma and Lakewood contain the largest concentrations of Pierce County's current population. Pierce County is also home to two sizable military installations, the Army's Fort Lewis Military Reservation and McChord AFB.

Fort Lewis supports 16,870 troops plus nearly an equal number of military dependants. Of these, 9,308 military personnel plus 9,192 dependants live on post, with the remainder residing in adjacent communities. In addition, 4,920 local civilians are employed by Fort Lewis. The Army expects to add 1,500 additional troops by the year 2003, many of whom will be accompanied by dependants (CH2M Hill 2001).

The population of McChord AFB includes 3,631 active duty personnel and 2,514 reserves. Of these, 1,441 live on base along with 1,669 out of a total of 4,547 dependants. In addition, 2,310 civilians are employed at McChord AFB (S. Eggman, pers. comm.).

No population growth estimates were available for Fort Lewis Military Reservation or McChord Air Force Base (AFB).

The City of DuPont lies in Pierce County to the east of the Nisqually delta. In 1992, the City of DuPont had a population of 600 people. This figure increased to an estimated 1,755 residents by 1999. By 2025, DuPont is expected to reach a population level of 10,994 people (OFM 2000). A significant component of DuPont's population and employment growth is located within a planned unit development currently under construction by the Weyerhaeuser Real Estate Company called Northwest Landing. Northwest Landing is particularly relevant to the Nisqually NWR because portions of the Northwest Landing abut the Nisqually NWR and are visible from many places on the delta. Completed portions of the 3,000-acre project currently accommodate approximately 2,000 residents. At full build-out in 2010, the project may grow to 11,000 residents and 20,000 jobs (Martinson, pers. comm.).

In 1998, almost 80% of Pierce County's population was Caucasian. African Americans comprised the largest minority population, making up approximately 7% of the population; Asians and Pacific Islanders comprised 6% of the population, with a variety of minorities comprising the remainder (National Association of Counties 2000).

3.8.1.2 Employment and Income

Thurston County

The Thurston County economy is primarily supported by employment by the State government, headquartered in Olympia. In addition to providing the largest share of the county's jobs, the government sector also provides the highest average wage.

The real (adjusted to account for inflation in 1998 dollars) per-capita income was $28,443 in 1998 (Thurston Regional Planning Council 2000). In 1998, 48.1% of wages and 39.3% of employees were based in the government sector. Also in 1998, the service industry was responsible for roughly 23% of employees and 20% of wages. Retail trade was responsible for just under 20% of employees and about 10% of wages. Manufacturing, construction, agriculture, forestry, fishing, transportation, and wholesale covered about 17% of employment and wages. In total, 4.6% of the county's labor force (4,600 workers) were unemployed in 1999, slightly lower than the statewide average of 4.7% (Thurston Regional Planning Council 2000).

Pierce County

The Pierce County economy is primarily supported by employment in the Fort Lewis-McChord AFB military complex, the City of Tacoma, local manufacturing in Tacoma, and aerospace-related industries. The largest employment sectors include services, government, and retail trade. The three largest individual private employers are all hospitals (Tacoma-Pierce County 2001).

The closest major employers to Nisqually NWR are Intel and State Farm Insurance, which both maintain large campuses in DuPont's Northwest Landing with a combined total of approximately 2,750 employees (Northwest Landing 2001). Employment within the Nisqually River Valley itself primarily includes education, retail trade, government, tourist services, agriculture, and forest production and harvesting (Pacific Coast Joint Venture 1996; Consoer et al. 1974).

In 1998, real Pierce County per capita income was estimated to be $27,493 (Tacoma-Pierce County 2001). The largest employers were in the services sector (27%); Federal, State, and local government (21%); and retail trade (20%). Manufacturing, construction, real estate, agriculture, forestry, and other services in the industrial sector comprised approximately 25%, with the remaining 7% employed in other sectors. In 1999, Pierce County had a resident civilian unemployment rate of 4% (Tacoma-Pierce County 2001).

3.8.1.3 Transportation Patterns

The major transportation corridor providing access to Nisqually NWR is I-5, a major interstate highway linking many cities and major destinations in western Washington. I-5 provides convenient, direct access to Refuge lands at the Nisqually Interchange, Exit 114. In 2000, the Washington Department of Transportation (DOT) estimated traffic flow past Exit 114 at approximately 72,400 trips west of Exit 114 per day and 79,700 vehicles per day east of the Nisqually exit. In 1999, average daily flow of traffic was more than twice what it was in 1976. Peak traffic can reach as high as 132,000 vehicles per day (R. Decker, pers. comm.). Ramp

counts of vehicles using Exit 114 were 1,550 westbound vehicles entering the freeway per day. Daily counts of vehicles exiting the freeway and Exit 114 averaged 1,450 and 5,100 westbound and eastbound, respectively. Three-fourths of the residents of Pierce County who commuted to Olympia or elsewhere in Thurston County passed the Refuge to and from work (PSRC 1993).

The CCP Study Area contains a network of arterial roads that bisect the area. I-5 is the predominant transportation corridor with great impacts on the Refuge including traffic noise and an ecological barrier for many terrestrial wildlife species. In addition to I-5, there are several arterials including Old Pacific Highway, Reservation Road, Martin Way, Meridian Road, Nisqually Cut Off, Steilacoom Road, and Meridian Road in Thurston County. Many of these roads in the Nisqually Valley south of I-5 are "rural" in character with few shoulders and designed for low traffic volumes. Thurston County's Transportation Goal for the Nisqually Valley Sub-Area states: *Develop a transportation system which addresses regional needs while still retaining the rural character of the Nisqually Planning Area and primarily the agricultural lands along the valley floor (Thurston County Planning Department 1992).*

The Thurston County transportation planning that occurred in the early 1990s has been effective in directing new roads and commuter traffic away from the valley and preserving its rural character. In addition, County plans contain strategies to add a non-motorized path and trail system in the valley, preserve historic resources such as barns and the old Nisqually School, and add a system of interpretive signs. The proposed trail would connect to Nisqually NWR and connect key view points.

In Pierce County are Mounts Road as well as a network of new roads associated with the Northwest Landing development. The City of DuPont has proposed a road parallel to the east bluff of the Refuge. The exact location of this road is somewhat flexible.

The Burlington Northern Santa Fe Railway line extends from Tacoma through and along the east side of the Refuge to Vancouver, Washington. This line is used by Washington State Department of Transportation (WSDOT) as part of the Federally designated Pacific Northwest High Speed Rail Corridor. Over the next 20 years, there are plans to increase the number of mainline tracks from two to three south of I-5 and to reconstruct and reroute the Pt. Defiance Bypass and branch line connecting Lakewood and Tacoma. The Service will work with the WSDOT Rail office in Olympia to coordinate rail line improvements with proposed Refuge expansion.

3.8.2 Environmental Justice

In February 1994, President Clinton issued Executive Order 12898, requiring that all Federal agencies seek to achieve environmental justice by "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (Executive Order 12898). Environmental justice is defined as the "fair treatment for people of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies."

The U.S. Department of Housing and Urban Development (HUD) defines low income as 80% of the median family income for the area, subject to adjustment for areas with unusually high or low incomes or housing costs. The 1999 estimated median family income was $43,475 in Thurston

County and $43,624 in Pierce County, respectively. This compares with an estimated state-wide median income of $48,289 (OFM 2001). Since median family incomes for both counties were approximately 90% of the state median family income, neither county would be classified as low income. Caucasians made up about 90% of Thurston County's population and 80% of Pierce County's population in 1997 and 1998, respectively. Significant minority populations included Asians and Pacific Islanders and African Americans (National Association of Counties 2000).

The 400-member Nisqually Indian Tribe's reservation is located within the Nisqually River Valley, making the tribe the minority group most affected by the CCP alternatives. In addition to the tribe's reservation, there are numerous parcels of Nisqually Trust land in the Valley, as well as the newly acquired 325-acre Braget parcel which is located within the Refuge.

3.8.3 Land Use

This section presents an overview of land uses within the study area. Because the Refuge straddles the boundaries of both Pierce and Thurston counties, the land use practices and regulations of both counties are presented. This section also emphasizes the lands comprising the Nisqually delta, especially special status lands within the study area such as the site's National Natural Landmark designation, Research Natural Area, Nisqually Public Use Natural Area, Shoreline of Statewide Significance, and National Recreation Trail.

3.8.3.1 General Land Use and Management

Historically, the Nisqually delta supported a variety of land uses, including subsistence hunting and gathering, logging, commercial shipping, recreational and commercial fish and shellfish harvesting, and agriculture (Burg 1984). Today, low density residential and agriculture constitute the prevailing land uses surrounding the Refuge (Thurston County Dept. of Water and Waste Management 1993). The Refuge itself provides open space and quality wildlife habitat and wildlife-dependent recreation and education to an expanding regional population (Pacific Coast Joint Venture 1986).

Growing demand for residential, commercial, and industrial land poses continuing threats to natural resource areas, including estuaries, freshwater wetlands, and agriculture (Klein and Reganold 1997). In 1990, Thurston County adopted an ordinance that allows development on rural lands to a density of 1 dwelling unit per 5 acres. In 1992, the Thurston County Planning Department created the Nisqually Planning Area south of I-5 to protect the Refuge from adjacent developments. The boundaries of this area, shown on Thurston County planning maps as the "Heart of the Valley," fall within the CCP Study Area south of I-5 (OFM 2000). To maintain the existing rural environment of the Nisqually River Valley, agricultural lands in this area became part of Thurston County's Purchase of Development Rights (PDR) program since 1994 (Thurston County Planning Department 1992). The PDR program permanently preserves farmland while supporting the farming community. The PDR program is administered by Thurston County using perpetual conservation easements attached to each deed. Within the 840 acres of PDR properties, agricultural uses would continue. These can include growing, raising, and producing horticultural and agricultural crops, as well as the processing and marketing of these products. Other uses include raising, processing, and marketing of animals and the lying

fallow or disuse of the land. Structures allowed can include residences, barns, machine sheds, permanent greenhouses and associated structures, retail and processing facilities, surfaced parking areas, surfaced driveways, surfaced roadways, and surfaced pads. Non-tillable surfaces can include asphalt, concrete, gravel, and any other material not normally associated with soil cultivation. Structure placement and non-tillable surfaces could occur on up to 5% of any parcel or lot and result in approximately 44 acres being removed as potential wildlife habitat.

Pierce County has a similar PDR program called "Conservation Futures," administered by the Pierce County Parks program. Conservation Futures is a land preservation program for the protection of threatened areas of open space, timber lands, wetlands, habitat areas, and agricultural lands within the boundaries of Pierce County. Conservation Futures funds are used to acquire the land or the rights to future development of the land (Pierce County 2001).

Consistent with State Growth Management Act (GMA) and County planning requirements, population growth in Washington is directed within incorporated cities and designated urban growth areas. The City of Lacey's urban growth area (UGA) is just west of the Nisqually Valley. Since 1995, a number of new homes have been constructed along the eastern edge of the UGA, close to the edge of the plateau which overlooks the Nisqually Valley (Thurston Regional Planning Council 2000). New single-family home construction activity is also occurring within the Nisqually Valley south of the Refuge both on and in the vicinity of the Nisqually Indian Reservation.

Under Thurston County's Nisqually Sub-Area Plan (Thurston County Planning Department 1992), much of the land in the Nisqually Valley is zoned Rural Residential in recognition of the limited water supply, and agricultural and delta resources of the valley. The Refuge itself is designated Public Reserve in the Sub-Area Plan. In general, land zoned Rural Residential may be developed for single-family housing with development densities of up to 1 dwelling unit per 5 acres.

The portion of the Nisqually River Valley referred to above as "the Heart of the Valley" is protected with a special zoning designation of Nisqually Agriculture (NA). Agricultural activities, including logging and other forestry practices, are the primary uses within this zone. Housing and other development are permitted, but only ancillary to agriculture. The development standards mandated by this zone are unique to the Nisqually Planning Area, and this zone is applied to those lands within the Nisqually Planning Area that: (1) contain large farms on primary agricultural soil, (2) have been farmed for several generations, or (3) are enrolled in or eligible for enrollment in the Agricultural Open Space Tax Program (Thurston County 2001).

Some local jurisdictions are actively preserving their natural heritage. The City of DuPont, for example, has identified 22% of the land area as open space to protect wetlands, steep slopes, buffers, and other areas, including an oak savannah habitat (P. Clarke, pers. comm.).

Major land uses on Fort Lewis properties include cantonment (temporary living quarters for troops), range, and training areas. Effect areas such as artillery ranges are surrounded by buffer areas to prevent noise and safety effects to surrounding areas. Fort Lewis lands between the bluff and the Nisqually River buffer the range, located on the prairie above the bluff. At this time, the range is expected to remain operational for the foreseeable future; the Army expects to continue

to rely on its holdings between the range and the river as an un-populated buffer area (W. Vanhoesen, pers. comm.).

3.8.3.2 Special Status Lands

The Service manages several areas on the Refuge that fall under special designations. These are shown in Figure 3.8-1 and described below.

National Natural Landmark Designation

The Nisqually delta was added to the National Park Service's Registry of Natural Landmarks in March 1971 (Boyer 1993). The designation was based on its significance as one of the best examples of a nationally representative river delta and estuarine ecosystem (Washington State Game Department 1971; USFWS 1978). The delta supports one of the five highest quality known examples of Washington and Oregon salt marshes (Friedman 1987).

The designated 2,765-acre landmark includes public and private ownerships of land, including lands of the National Audubon Society and WDFW. The 1,000 acres of diked Refuge lands are not included in the designation. The landmark status holds no legal obligations; however, the Service has a resource management responsibility for high quality habitat types, as recognized in the Landmarks Program (USFWS 1978).

Research Natural Area

Located at the mouth of the Nisqually River, the 793-acre Nisqually delta RNA was established by the Service in 1989 (Caicco 1989b). RNA objectives are limited to: (1) preserving and protecting the delta as a significant natural ecosystem; (2) serving as a gene pool for the preservation of native and endangered species; and (3) providing educational and research areas for the study of scientific aspects, including successional trends. Management activities that modify or alter natural ecological processes, including consumptive uses, are not allowed in RNAs (CH2M Hill et al. 1978; USFWS 1981). The Nisqually RNA boundaries are as follows: the east boundary of the RNA runs along the border of the East Bluff; the north boundary runs along the Nisqually Reach; and the west boundary runs along the Thurston-Pierce County line. The southern boundary generally runs east-west from the top (northernmost section) of the Brown Farm Dike across to the East Bluff.

A candidate RNA on Fort Lewis property is located in the Nisqually floodplain, along the eastern bank of the river, partially within the CCP Study Area. The boundaries of this Nisqually Floodplain Candidate RNA include the Nisqually River to the west, the top of the Seventh Infantry Bluff to the east, I-5 to the north, and the confluence of Muck Creek and the Nisqually River to the south. This area is representative of a low elevation stream and riparian system in the Puget Trough. Nearly all of the original low elevation riparian systems in the Puget Trough have been converted to agriculture or have been altered for development. The Nisqually Floodplain Candidate RNA is the largest remaining example of such a system in this physiographic province. This riparian system has statewide significance. Contained within the upland bluffs rising from the river valley, old river channels, oxbows, and other hydrogeomorphic

Figure 3.8-1. Special Designated Areas

Back of Figure 3.8-1

features illustrate the dynamic processes of a low elevation riparian floodplain system. The mosaic of vegetation communities found within the floodplain supports rich and varied wildlife use.

Nisqually Public Use Natural Area

Forty acres of the Nisqually River surge plain in the Refuge were designated as a Public Use Natural Area (PUNA) in 1990 (Caicco 1989a). PUNAs are designated by the Service to ensure the preservation of significant Refuge natural areas through restricted public access (USFWS 1981). Permitted public use activities are hiking, birdwatching, and fishing. The high quality freshwater surge plain includes a forested riparian area with a dense shrub layer along the west bank of the Nisqually River. The river is influenced by tidal waters from Puget Sound (Kunze 1984; Caicco 1989a). During high tides and floods, overflow in tidal channels carries fresh and slightly brackish water into and over the wetland area (Caicco 1989a).

Shoreline of Statewide Significance

In 1976, the Thurston County Shoreline Master Program designated the Nisqually Reach and River, from Alder Lake to Puget Sound, as shorelines of statewide significance (Giebelhaus 1998). The program segments the shoreline into different designations to regulate development (Thurston County Planning Department 1992; see F,S,L Policies, Plans and Zoning section).

Shoreline regulatory criteria protect water quality, aquatic habitats and public health, and public access, which preserve or enhance shoreline characteristics that existed prior to public access, and require preservation of aesthetic, scenic, historic, or ecological qualities (Thurston Regional Planning Council 1990).

National Recreation Trail

The Brown Farm Dike was designated as a National Recreation Trail in 1981 (Boyer 1993) as a result of the National Trails System Act of 1968. National recreation trails provide for a variety of outdoor uses in or near urban areas. The 5½-mile dike trail designation allows for appropriate public uses on Service lands. The Service retains full latitude to control or restrict public use of the Brown Farm Dike in favor of wildlife resources (Waddell 1981; Watt 1981; Heritage Conservation and Recreation Service no date).

3.8.4 Refuge Management Economics

The existing Refuge staff consists of eight permanent and two temporary employees who account for an annual payroll (including salaries and benefits) of approximately $380,000.
Seventy trained volunteers are part of the Refuge's volunteer program. In 1999, volunteers contributed 8,000 hours assisting with the public use and biology programs, and maintenance and administration of the Refuge. Training for new volunteers is conducted once a year.

In addition to providing salaries and benefits, the Refuge purchased goods and services totaling approximately $948,000 in 1999, approximately 70% of which was spent in Thurston County.

Some of these expenditures (e.g., for flood damage restoration and maintenance management system projects) were one-time costs and are not expected to be repeated. The baseline non-salary costs of Refuge management were estimated at approximately $197,000 per year, mostly for operations and maintenance activities. Approximately 30% of these purchases involve wildlife- and habitat-related projects, with the remaining 70% involving public use-related projects.

National Wildlife Refuges contribute funds to local counties through two revenue sharing programs, one that applies to Refuge lands reserved from the public domain, and one that applies to lands purchased in fee title. The majority of lands comprising the Refuge are held by the Service in fee title. For fee lands, the Federal government typically pays the counties up to 0.075% of the appraised value of the land each year out of the Refuge Revenue Sharing Fund. In 1999, for example, the Federal government paid $2,613 to Pierce County and $18,167 to Thurston County.

3.8.5 Area Recreation Sector

In 1996, 45% of Washington State's adults age 16 and older participated in outdoor recreational activities that included some form of hunting, fishing, or wildlife-watching. Thirty-nine percent of Washington State's adults participated in wildlife-watching. Additionally, in 1996 almost $3 billion was spent on wildlife-associated recreation in Washington, and over $1.6 billion of the $3 billion was spent on wildlife-watching. Consumer spending for wildlife-watching has a significant effect on local, state, and national economic activity and employment. Wildlife-watching can directly benefit the local economies around the Nisqually Valley. Benefits can be derived through sales of food, lodging, and transportation, as well as through expenditures such as binoculars, cameras, books, wild bird food, and touring vehicles (Gibilisco and Filipek 1998). The increasing economic benefits from wildlife-associated uses create a compelling need for greater conservation of the delta's natural resources, which help generate these funds.

3.8.5.1 Thurston County

Thurston County Parks and Recreation developed a full range of recreation opportunities to support the recreation needs of its residents. Thurston County provides many cultural, historic, natural, passive interpretive, and other recreation opportunities. County Natural Area Preserves focus on preserving natural areas (Thurston County Parks and Recreation Department 1996).

Thurston County policy is to acquire land and develop its resources to support the leisure activities of residents and visitors. Along with State and Federal lands, Thurston County is establishing a coordinated approach to recreation services with the cities of Olympia, Lacey, and Tumwater. These cities maintain approximately 1,222 acres of park lands. Rural Thurston County cities maintain an additional 80 acres of park lands (Thurston County Parks and Recreation Department 1996).

In 1996, the Thurston County Parks and Recreation Department had a total land inventory of 2,595 acres of park lands, recreation lands, trails, and open space preserves. Twenty-one Thurston County parks include six natural area preserves and 23 miles of trails. Sixteen parks

have freshwater and saltwater access. Roughly 7½ miles (39,580 feet) of freshwater waterfront can be accessed, as well as over ½ mile (3,296 feet) of saltwater access (Thurston County Parks and Recreation Department 1996). Trail systems, such as the Chehalis Western Trail (southwest of Nisqually NWR) and the Yelm-Tenino Trail (south of Nisqually NWR), provide a regional system of trails for walking, bicycle, equestrian, and hiking use (Thurston County Parks and Recreation Department 1996).

The Nisqually Sub-Area Land Use Plan recommends that the Thurston County Public Works and the Thurston County Parks and Recreation departments work together with DOT, the City of Olympia, and local bicycle clubs to locate park and bike locations at areas such as the Nisqually Interchange, McAllister Springs, Old Nisqually, and the Nisqually Tribal Center. South of McAllister Springs, State Route 510 has an improved bike lane adjacent to the travel lane (Thurston County Planning Department 1992). The Thurston Regional Transportation Plan recommends that bike lanes be constructed with all future road projects of regional significance (Thurston Regional Planning Council 1997).

3.8.5.2 Pierce County

The Pierce County Parks Department maintains over 2,000 acres at over 30 park sites, including two recreation centers, five boat launch sites, trail corridors, and a large variety of passive and active facilities (Pierce County 2001). Pierce County also offers a number of outdoor recreation opportunities. The Foothills Trail is a planned 25-mile trail initiated in 1991 for non-motorized users. The trail parallels the Puyallup River from McMillin to Carbonado. Four trail sections of over 8 miles are open to the public. Popular bicycle trails include a 7-mile trail at Fort Steilacoom Park and a 3-mile Breseman Forest trail system at Spanaway Park. Other shorter trails for non-motorized users can be found at Seeley Lake Park, the wooded Chambers Creek Trail, Sunrise Beach Park, and Lake Tapps Park. Waterfront sites can be found at Half Dollar Park, Orangegate, Parkland Habitat, Rimrock Park, Riverside Park, South Hill Park, Swan Creek Park, and Wilkeson Creek Park (Pierce County 2001). The Pierce County growth management plan also lists a trail in the planning stage from Nisqually NWR to Mount Rainier.

A goal of the 1995 DuPont Comprehensive Plan is to develop a system of parks and open spaces that provides for passive and active outdoor recreation, preserves cultural and archeological sites, and protects unique physical features. Preservation of oak savannah habitat with limited trails and buffering and providing trails around creeks and wetlands are policies of the plan. A pedestrian trail system is recommended to enhance public enjoyment of natural areas, historic and cultural sites, and scenic views (McConnell/Burke et al. 1995).

3.8.5.3 Nisqually NWR

More than 100,000 people per year visit the Refuge to participate in a variety of wildlife-dependent recreational and educational activities. These include wildlife observation, photography, interpretation, environmental education, and fishing. These visits include approximately 5,000 students and teachers from King, Pierce, Thurston, and Mason counties who visit the Refuge to participate in the environmental education program.

Located adjacent to a major interstate highway, Nisqually NWR is also likely to continue to serve as a secondary destination for visitors en route to better known recreation destinations such as Mount St. Helens National Volcanic Monument and Mount Rainier, North Cascades, and Olympic National Parks.

3.8.6 Agricultural Sector

Approximately 1,108 acres of agricultural lands are located within the CCP Study Area. The principal crops grown in this area that represent the majority of economic activity include hay, corn, and Christmas tree farms. Agricultural uses in Thurston County cover 56,000 acres and produced $36 million worth of farm products in 1997 (Thurston Regional Planning Council 2000). The Nisqually River Management Plan (Nisqually River Task Force 1987) states that enhancement of the natural-resource-based economic sectors and supporting land uses should be preferred to others throughout the river valley.

Agriculture is expected to remain an important component of the south Puget Sound economy, but farmland is increasingly being subdivided and developed for other uses (Pacific Coast Joint Venture 1996). In Thurston County, farmland conversion to non-farm uses is often associated with increases in land values and property tax assessments. Environmental regulations requiring expensive and complex livestock waste management have also resulted in the reduction of land in dairy farms (Klein and Reganold 1997). Traditional local resource-based economies are expected to decline in the area, and commercial activities such as manufacturing, trade, and service-related industries such as outdoor recreation and tourism will continue to grow and diversify (Pacific Coast Joint Venture 1996). The County has addressed this concern through its PDR program (see Section 3.8.3.1).

3.8.7 Commercial Shellfishing

At Nisqually NWR, shellfishing is allowed throughout tidal habitat, under State regulations. Research Natural Area closures are currently not being enforced.

Commercial shellfish growers in Thurston County marine waters use about 10,000 acres of commercial shellfish beds. More oysters are grown here than anywhere else in Puget Sound. Shellfish growers support the Puget Sound shellfish industry by producing about 120,000 gallons of oysters and 140,000 pounds of clams annually. Over ten million pounds of geoduck clams, worth $60 million, are found subtidally (Thurston County Advance Planning and Historic Preservation 1994). However, commercial goeduck tracts in the Nisqually Reach have never been open because of seasonal pollution due to heavy rainfall events.

The commercial shellfish growing area incorporating 2,130 acres of the Nisqually Reach was downgraded in 1992 from “Approved” to “Conditionally Approved” by the State Health Department. On November 1, 2000, 74 of these acres near Luhr Beach were further downgraded to “Restricted” meaning no commercial shellfish harvest is allowed. Both downgrades were due to elevated levels of fecal coliform bacteria (S. Davis, pers. comm.). Operations for geoduck harvesting in the delta are being considered by the Nisqually Indian Tribe (Washington State Department of Health 1997).