Chapter 4. Environmental Consequences

This chapter identifies the effects of the four alternatives described in Chapter 2 (Table 4.0-1) on various aspects of the environment within the CCP Study Area. Alternatives under consideration could have effects on a wide range of existing Refuge characteristics. This chapter is organized similarly to the Affected Environment chapter. Effects of each alternative are described in three main action categories–Habitat Restoration, Refuge Expansion, and Public Use Program. Also see Table 4.9-1 at the end of the chapter for a summary of effects.

Table 4.0-1. Brief Summary of Alternatives Described in Chapter 2.

Alternative	Habitat Restoration	Refuge Expansion	Public Use Program
A	Minimal improvements within diked area	No Refuge expansion	Continue to provide limited environmental education (EE) program (5,000 students); no changes to trail system, hunting, or fishing access
B	318 acres muted estuarine and 140 acres full estuarine restoration, improved management of 542 acres freshwater wetlands	Proposed 2,407 acres of Refuge expansion along East Bluff and south of I-5	Greatly expand EE program (20,000 students), minor changes to trail system, hunt closure enforced, no changes to fishing access
C	515 acres of estuarine restoration, improved management of 447 acres of freshwater wetlands, 38 acres riparian restoration	Proposed 2,407 acres of Refuge expansion along East Bluff and south of I-5	Expand EE program (15,000 students), trail reduced to 3¾- mile loop and boardwalk trail, new eastside trail, new accessible fishing site at Luhr Beach and Nisqually River, 713 acres of Refuge open to hunting (with restrictions)
D	699 acres of estuarine restoration, improved management of 263 acres of freshwater wetlands, 38 acres riparian restoration	Proposed 3,479 acres of Refuge expansion along East Bluff, south of I-5 and Nisqually River corridor	Expand EE program (15,000 students), trail reduced to 3½-mile round-trip (with boardwalk in estuary), new eastside trail, new accessible fishing site at Luhr Beach and Nisqually River, 191 acres of Refuge open to hunting

4.1 Effects to the Physical Environment

4.1.1 Alternative A

4.1.1.1 Habitat Restoration

Effects to Hydrology

Under the No Action Alternative, no significant changes to hydrology are anticipated. The Nisqually River and McAllister Creek would continue to be contained by dikes in the delta, restricting the flow and natural movement of these waterways. Seepage of tidal waters through the dikes would continue until dikes are repaired. In the long term, global warming and associated sea level rise would be expected to make dike maintenance more difficult.

Minimal changes in flood storage area would occur, and flooding frequency and duration would not be influenced. Extreme flood events could continue to result in a large surge of water into the diked area through two major overflow channels. Wetland hydrology within the diked area would remain as it is currently. Any changes would be similar to those that are currently taking place, as the invasive reed canary grass encroaches upon open water areas. Existing levels of groundwater use would continue. Some limited improvements in water management would occur as a result of water control structure replacement or installation.

Effects to Soils and Sediments

No significant changes to soils or sediments are anticipated. Sediment carried by the Nisqually River would continue to be deposited at the mouth of the river and in deeper portions of the Nisqually Reach, except during extreme flood events that flood the Refuge through overflow channels or breached dikes. Subsidence associated with diking and draining of organic (wetland) soils would continue as these soils decompose during dry periods. Extensive dike repairs would be necessary to strengthen the dike to retain the freshwater impoundment and prevent further dike failure. The dikes were further weakened by the magnitude 6.8 Nisqually Earthquake in February 2001, which created thousands of lineal feet of cracking on the surface of the dike and its slopes, and severely fractured a 500-foot section. Repairs may include topping or stripping the dike, installing erosion fabric on the outboard side of the dike, graveling or depositing fill along or on top of the dike, and filling seeps, among other measures. Some disturbance to existing soils or sedimentation due to construction or added fill would occur during dike repair.

Effects to Geology

The only effect to geology anticipated under Alternative A is the possibility of increased erosion of the bluffs that flank the east and west side of the Refuge. While bluff erosion is a natural process throughout Puget Sound, development of homes along the edges of bluffs and the removal of trees and other vegetation by property owners seeking to improve their view often accelerate this process (Menashe 1993).

Effects to Water Quality and Salinity

Alternative A would cause little direct change to water quality or salinity parameters. Water chemistry, temperature, and risk of contaminant release would remain unchanged. Some localized, short-term effects might occur associated with dike repairs. Water quality would continue to decrease in the summer months within the diked area due to lack of water circulation, particularly in the borrow ditch. Indirect benefits to water quality would occur if efforts to strengthen watershed protection through partnerships outside of the Refuge boundary were successful.

Effects to Air Quality

No significant changes in air quality are anticipated with Alternative A. Factors that could affect air quality, such as construction and traffic, would not change from current conditions.

4.1.1.2 Refuge Expansion

Effects to Hydrology, Soils and Sediments, Geology, Water Quality, Salinity, and Air Quality

Other than the completion of the existing approved Refuge boundary, there is no Refuge expansion proposed in this alternative. There are no effects anticipated to hydrology, soils and sediments, geology, water quality, salinity, or air quality that are different than that described above in the Habitat Restoration section.

4.1.1.3 Public Use Program

Effects to Hydrology, Soils and Sediments, Geology, Water Quality, Salinity, and Air Quality

There are limited changes to the public use program in Alternative A; therefore, no major consequent changes are anticipated to hydrology, soils and sediments, geology, water quality, salinity, or air quality. Extensive dike repairs would be necessary to strengthen the dike that supports the 5½-mile Brown Farm Dike Trail. Potential effects associated with dike repair would be the same as described above in the Habitat Restoration section. A primitive loop trail would be established in the surge plain forest in this alternative to replace a trail lost during the 1996 flood. It would be minimally maintained, so no gravel or other fill would be added to this tidal habitat. Effects on hydrology, soils or sediments, or water quality should be minimal from trail use. Boat and PWC use on the Refuge would continue to be a source of gas and oil pollution in the water. Erosion of salt marsh areas caused from wakes created by boat and PWC use in shallow areas would also continue. Bank fishing and shellfishing may have some effects on soils due to foot traffic and digging in the mudflats. Motorized boat wakes and propellers would continue to cause some amount of soil disturbance in tidal areas.

4.1.2 Alternative B

4.1.2.1 Habitat Restoration

Effects to Hydrology

Under Alternative B, more intensive management of freshwater wetland habitats inside the diked area would increase groundwater use, as greater volumes of water are withdrawn to control reed canary grass. Changes in wetland hydrology within management units would include creation of impoundments and more intensive water level management, and these areas would be wetter for longer periods during the year. Other effects to wetland hydrology would be associated with estuarine habitat restoration and associated changes from seasonally to semipermanently flooded freshwater (palustrine) wetlands (see Figure 3.2-2) to regularly flooded estuarine (tidal) conditions. Areas that would be restored to muted tidal influence may retain more water for a longer period of time than those fully restored areas where dikes have been removed, particularly in borrow ditches and lower elevations (Appendix J [ENSR 1999]). While there would be an increase in the flood storage area of the lower Nisqually River, no measurable upstream flood relief benefits are expected (ENSR 1999). Extreme flood events would continue to result in a large surge of water into the diked area through two major overflow channels.

Effects to Soils and Sediments

Alternative B would have little effect on sediment deposition. Dikes along the river would continue to direct river-borne sediments out toward the delta. Deposition rates would be very low in breached areas, even during flood events when sedimentation is higher, because of the limited direct hydrological exchange between the restored area and the Nisqually River, the primary source of sediment (ENSR 1999). High volumes of water draining through breaches may lead to water velocities capable of eroding existing sediments outside the dike during ebb tides (ENSR 1999). Bridged breaches would need to be stabilized through the use of riprap and wing walls to prevent erosion or widening of the breaches. Some effects on soils and sedimentation are expected as a result of dike removal and construction. Filling the borrow ditches, adding new fill material for exterior and interior dikes, and repair of existing dikes would cause soil disturbance during and after construction, until soils have stabilized. Extensive dike repairs would be necessary to strengthen the existing dike to retain the freshwater impoundment and prevent further dike failure (see Alternative A). Repairs would cause some disturbance to existing soils, or sedimentation due to added fill until soils stabilized.

Based on comparison of topographic elevations inside and outside the diked area, subsidence has occurred inside the diked area. This observation is consistent with other diked areas, where marsh surface elevations began to increase following dike breach restoration (Mitchell 1981; Frenkel and Morlan 1990). Restoration of tidal influence arrests oxidation of organic soils and associated subsidence. Sediment accretion also increases estuarine habitat elevations. In intertidal areas with elevations sufficiently high to support salt marsh vegetation, organic soils would slowly begin to rebuild, reversing the effects of subsidence over time. However, sediment

accretion would be limited in the muted tidal area because of limited breaches and the continued presence of dikes (ENSR 1999).

Intensified management within the diked area would include discing and sculpting to improve freshwater wetlands and grasslands. These activities may have short-term effects on soils and sedimentation. Timing, extent, contouring, and reseeding would be designed to minimize erosion and sediments in runoff.

Effects to Geology

Action Alternatives (B, C, and D) include expansion of Refuge holdings along valley bluffs, especially on the east side. Protection and revegetation of these areas may cause bluff erosion rates to stabilize.

Effects to Water Quality and Salinity

Alternative B would have little if any effect on the distribution of environmental contaminants. Two areas of potential concern, the orchard and Twin Barns (Momot 1993), would remain largely undisturbed. Some short-term effects to water quality are expected; specifically, biological oxygen demand (BOD) would increase locally from the die back and export of decaying plant matter (reed canary grass) as a result of tidal restoration. Intensified management within the diked area would include the limited use of fertilizer in the haying program. Timing and amount would be designed to minimize movement of nutrients into runoff.

In areas where tidal inundation is restored by dike removal, significant salinity concentrations are expected. However, the presence of dikes with breaches would permit saline waters to enter the restored area only at certain locations, affecting the overall pattern of saltwater influence. In places where salinity is reintroduced, soil salinity (pore water salinity) would increase, changing soil characteristics and associated flora (Frenkel and Morlan 1990).

Effects to Air Quality

Action alternatives (Alternatives B, C, and D) may result in minor effects to air quality from heavy equipment operation during dike breaching and removal. These activities may lead to local, short-term effects associated with fugitive dust and engine exhaust.

4.1.2.2 Refuge Expansion

Effects to Hydrology, Soils and Sediments, Geology, Water Quality, Salinity, and Air Quality

Moderate expansion of the Refuge boundary would benefit some of these physical factors. Refuge expansion could potentially protect and restore lands that would otherwise be developed for residential or commercial development or that would not be restored. Additional protection of areas along the East Bluff north of I-5 would prevent accelerated bluff erosion caused by development. Retaining more of this bluff habitat in a natural, vegetated condition may improve

water quality in wetlands and waterways by reducing sedimentation and nonpoint source contamination from stormwater and runoff from adjacent developments and roadways. Areas that have been logged on the East Bluff would be reforested, improving watershed protection. Similar benefits would be gained by stronger protections for bluff habitats south of I-5.

Refuge expansion south of I-5 could lead to freshwater wetland protection and restoration, which may benefit hydrology and water quality. Wetland areas store flood waters and help maintain water quality by trapping sediments and removing excess nutrients. Air quality may decline if residential and commercial development increases in the study area, as effects associated with increased traffic, industrial development, and other pollutant sources such as wood stoves increase. Refuge expansion would reduce this possibility. However, only limited benefits would occur along the Nisqually River corridor south of I-5 since only a small area would be included. In addition, approximately 386 acres within the Nisqually Valley could not be provided further protection from development and gravel mining in comparison to Alternative D, which would negatively affect some of these physical factors.

4.1.2.3 Public Use Program

Effects to Hydrology, Soils and Sediments, Geology, Water Quality, Salinity, and Air Quality

Changes in the public use program under Alternative B are not expected to cause large changes in hydrology, soils and sediments, geology, water quality, salinity, or air quality. Minor changes in the trail system would still require extensive dike repairs, as described in Alternative A, since a large proportion of the existing dike would remain to support the Brown Farm Dike Trail. Some disturbance to existing soils, sedimentation, or added fill may occur during dike repairs and construction of new interior dikes for the freshwater units. New study sites established for the enlarged environmental education program would produce localized areas of soil compaction from foot traffic, but locations would be selected to minimize effects.

Effects from bank and shellfishing would be similar to Alternative A. Differences would be in the enforcement of closures to consumptive uses in the RNA and hunting on Refuge lands. These closures would reduce foot, boat, and PWC traffic in mudflats and salt marsh areas and reduce gas and oil pollution in the water. Motorized boat wakes and propellers would continue to cause some amount of soil disturbance in tidal areas, although it would be reduced in the RNA due to winter and consumptive use closures and throughout the Refuge by boat speed restrictions. In addition, a new bank fishing area would be developed in the Trotter's Woods area, if acquired. Some effects on soils would occur from vehicle parking areas and foot traffic, but these would be expected to be less than current conditions because of planned improvements in access, including controlling vehicle use.

4.1.3 Alternative C

4.1.3.1 Habitat Restoration

Effects to Hydrology

Many of the changes in hydrology would be similar to those described under Alternative B, with the largest difference being the restoration of 515 acres to full tidal influence through the removal of dikes. The Nisqually River would be allowed to move more freely, overtopping its banks or changing course in areas where dikes are lowered to grade. The restored area would have a more direct hydrological connection to the Nisqually River and McAllister Creek than in Alternative B. Dikes would be removed to grade, and borrow ditches would be filled in the restored area; therefore, water retention during ebb tide would not occur as it would under Alternative B.

Hydrological changes in the area retained within dikes would be similar to those for Alternative B, except that the impounded area would be smaller and would contain five interior management units instead of five, with less overall storage capability. Extreme flood events would continue to result in a large surge of water in the remaining diked area through two major overflow channels. Water control structures, spillways, or pumps would be needed to reduce flooding more quickly within the dikes.

Effects to Soils and Sediments

Decrease in soil oxidation and associated subsidence would occur as described under Alternative B. Differences in effects between Alternatives B and C are largely associated with the difference in how tidal influence would be restored. Filling the borrow ditches, adding fill material to construct new exterior and interior dikes, and repairing existing dikes would cause soil disturbance during and after construction, until soils have stabilized. Alternative C would require less repair and maintenance of existing dikes than Alternative B.

Alternative C would lead to the removal of the dike along the west side of the Nisqually River and north of the Twin Barns area. This would allow for the river to discharge over a larger area, especially during flood events. Sediments carried by the river during floods would be deposited over a broader area, unlike Alternative B, and contribute directly to the restoration of estuarine habitats (ENSR 1999).

Intensified management within the diked area would include discing and sculpting to improve freshwater wetlands and grasslands, which may have short-term effects on soils and sedimentation. Timing, extent, and contouring would be designed to minimize erosion and sediments in runoff.

Effects to Geology

Alternative C includes the removal of the west bank river levee north of the Twin Barns. This would allow for the lower portion of the river channel to migrate naturally across the floodplain

and through the restored area. Changes in river channel location would alter patterns of river sediment deposition (ENSR 1999). No roads, buildings, or other infrastructure would be adversely affected if the Nisqually River changed its course in this portion of the study area.

Effects to Water Quality and Salinity

Alternative C would have no effect on environmental contaminants or short-term effects on BOD associated with export of decaying plant matter, as described for Alternative B. Additional effects on water quality parameters associated with these alternatives include potential water temperature decrease in the lower Nisqually River. Restoration of 38 acres of riparian habitat and improved protection of existing habitats may increase shading from vegetation cover with a corresponding reduction in water temperature**.** Intensified management within the diked area would include the limited use of fertilizer in the haying program, although the program would be reduced in area compared to Alternative B. Timing and amount would be designed to minimize movement of nutrients into runoff.

Alternative C does not include breached, bridged dikes but rather relies exclusively on the removal of the dike to grade. Therefore, salinity distribution patterns would be more typical of those associated with a natural estuarine system. Salinity distribution in turn affects soil and water salinity, soil characteristics, and the flora and fauna associated with estuarine habitats (Frenkel and Morlan 1990).

Air Quality

Same as Alternative B.

4.1.3.2 Refuge Expansion

Effects to Hydrology, Soils and Sediments, Geology, Water Quality, Salinity, and Air Quality

Same as Alternative B.

4.1.3.3 Public Use Program

Effects to Hydrology, Soils and Sediments, Geology, Water Quality, Salinity, and Air Quality

Except for those noted below, changes in these physical characteristics as a result of the public use program would be similar to Alternative B. Some disturbance to existing soils or sedimentation due to construction or added fill would occur during removal and construction of exterior and interior dikes. This effect is expected to be less than Alternative B. A new boardwalk section would be installed, extending from the new exterior dike along McAllister Creek. Boardwalk installation may have some short-term effects on soils; however, these would be minimized through the use of a pinned foundation boardwalk, eliminating the need to drive pilings into soils. Because boardwalks in tidal areas would be elevated, effects on hydrology should be minimal**.** In addition, a new 2½-mile loop trail would be installed east of the Nisqually River on Refuge and tribal lands. Large portions of the trail would be on existing low

roads and dikes. Boardwalk sections would be installed where water levels require them or dike removal is needed to support habitat restoration. A new bank fishing area on the east side of the Nisqually River along this new loop trail would be designed to minimize effects on soils through the placement and extent of the fishing area. The new hunting area on Refuge property is within the current unauthorized hunting area. Effects from boat activity associated with hunting would be similar to Alternative B but potentially increased because of the larger hunting area. Some effects to soils would also occur from foot traffic of hunters in mudflats and marshes. However, effects to soils and water quality would be reduced in McAllister Creek.

4.1.4 Alternative D (Preferred Alternative)

4.1.4.1 Habitat Restoration

Effects to Hydrology

Alternative D would lead to significant changes in wetland hydrology within the currently diked area, as 699 acres would be restored to tidal influence. As with Alternatives B and C, these effects would result in changes from seasonally flooded/saturated palustrine to regularly flooded estuarine conditions in restored areas. The Nisqually River would be allowed to move more freely, overtopping its banks or changing courses in areas where dikes are lowered to grade. The restored area would have a more direct hydrological connection to the Nisqually River and McAllister Creek. The McAllister Creek tidal system would be most functional in Alternative D because it would not be as constricted by dikes, allowing the major Shannon Slough system to become tidal over a greater area.

A smaller area of freshwater wetland management units would occur under Alternative D. There is an increased likelihood that water level manipulation would be effective in this smaller area and would be more intensively employed as a management technique. This may lead to increased use of groundwater resources as a water supply.

Alternative D is expected to reduce future flooding on the Refuge because the McAllister Creek overflow channel, which carried an estimated 30% of flood volume onto the Refuge in the February 1996 flood, would empty directly into McAllister Creek instead of into diked habitat (ENSR 1999). The second overflow channel, which carried the remaining 70% of the flood volumes in 1996, would continue to flow into the remaining diked area. Water control structures, spillways, or pumps would be needed to reduce flooding more quickly within the dikes.

Effects to Soils and Sediments

Alternative D would have similar effects on soils and sediments as described under Alternative C, although the size of the restored area is greater under Alternative D. Changes in soil characteristics associated with tidal inundation and salinity would occur over a broader area. As in Alternative C, more sediment would be deposited in the restored area due to dike removal along the Nisqually River (ENSR 1999). Sediment deposition may be slightly increased in the restored area along McAllister Creek during flood events because the McAllister Creek overflow

channel would empty directly into the restored area. Effects to soils and sediments as a result of dike construction and removal activities would be similar to Alternative C. Alternative D would require the least amount of dike repair.

The remaining diked area is the smallest in this alternative; intensified management would include discing and sculpting to improve freshwater wetlands and grasslands, which may have short-term effects on soils and sedimentation. Timing, extent, contouring, and reseeding would be designed to minimize erosion and sediments in runoff.

Effects to Geology, Water Quality, and Salinity

In general, effects would be the same as Alternative C. In addition, the larger amount of area restored along McAllister Creek could improve water quality due to increased tidal flushing and the larger amount of estuarine habitat, which could act as a filter for downstream flows before they reach the mouth of McAllister Creek and the Nisqually Reach.

Effects to Air Quality

Same as Alternative B.

4.1.4.2 Refuge Expansion

Effects to Hydrology, Soils and Sediments, Geology, Water Quality, Salinity, and Air Quality

Effects to these physical environment factors under this larger expansion of the Refuge boundary would be similar to those described for Alternatives B and C, with the following exceptions. Implementation of Alternative D would increase boundary expansion in the Nisqually River corridor and valley by more than 1,000 acres. Improved protection of this portion of the lower watershed would maintain or improve natural river processes that protect water quality, reduce flooding effects to human infrastructure, and distribute river sediments. Reduced development within the floodplain would allow for overbank flooding and decrease the need for river levees, bank stabilization, and other engineered approaches to flood control. Improved protection of the river corridor could reduce erosion and sedimentation, improving water quality.

4.1.4.3 Public Use Program

Effects to Hydrology, Soils and Sediments, Geology, Water Quality, Salinity, and Air Quality

Effects to physical environment factors would be similar to Alternative C. New boardwalk extensions along McAllister Creek would be longest in this alternative, affecting a slightly greater area during construction. Effects from boating activity associated with hunting would be similar to Alternative B, with somewhat more activity at the river mouth.

4.2 Effects to Vegetation and Habitat Resources

The effects to habitats, including estuarine, freshwater wetland, riverine and riparian, and upland habitats, are described below for each of the four alternatives. Effects to native, exotic (non-native), and invasive plants are also described.

4.2.1 Alternative A

4.2.1.1 Habitat Restoration

Effects to Estuarine Habitat

Maintaining the existing diked area would provide no new benefits for estuarine habitats within the study area. Additional estuarine habitat would not be restored, nor would the indirect benefits that existing habitats may receive by restoring adjacent diked areas to tidal conditions occur.

The existing dikes have some negative effect on the estuary. The dikes are potentially increasing tidal current velocity, which can contribute to the erosion of salt marsh and mudflat habitats (Burg 1984). The Nisqually River, and the sediments that it carries, would continue to be confined to its present course. This restriction, combined with reduced sediment load due to upstream dams (Nelson 1974), would continue to prevent a broader distribution of river sediments necessary to offset the effects of erosion and sustain estuarine habitats.

Retaining the dike would continue to interrupt tidal channels and keep the tidal prism, water volumes, and nutrient exchange reduced in existing estuarine habitats. This would limit the health and function of the salt marshes and sloughs of the delta, including the ability to provide habitat support for juvenile salmonids (Thom et al. 1985). Sediments would continue to deposit in artificial patterns, slowly contributing to the buildup of the bench surrounding the dike exterior. The reduced tidal prism and water volume would also continue to limit the creation of smaller channels and slough branches, producing a less complex, lower channel order system that provides less habitat for fish and other wildlife.

Effects to Freshwater Wetland Habitat

Existing diked areas would remain in their current condition with only limited improvements in management. In the short term, the existing mix of freshwater wetland habitats would persist. However, as discussed in Chapter 3, habitat conditions within the dike are slowly changing as reed canary grass dominance increases, modifying the vegetation community and reducing open water areas. Higher elevation, drier areas are changing to a scrub-shrub community. To slow these changes, an increased effort would be placed on reed canary grass management, including mowing, discing, and herbicide application. However, due to the size of the management area, feasibility of access in a moist soil environment, freshwater supply limitations, limited effectiveness of flooding to prevent regrowth, and concerns about widespread herbicide use within the Refuge, these measures would be limited in their effectiveness. It is expected that

deterioration of freshwater wetland conditions would continue, as well as decreased wildlife habitat function. Replacement or addition of water control structures would provide some limited improvements in water management, allowing ponding over longer periods in some wetlands. The entire dike would also need major repairs to prevent seepage and eventual failure. If the dikes were to breach, they would be repaired as soon as possible to stop tidal flooding.

Effects to Riverine and Riparian Habitat

No focused efforts to restore riverine and riparian habitats associated with natural hydrology would occur under Alternative A. Native tree and shrub plantings would continue to restore riparian habitat within the diked area, but these diked areas would not be associated with a hydrological connection with the Nisqually River or McAllister Creek. Efforts to conserve existing habitats would continue, including preservation of riparian vegetation along dikes where possible. Extensive dike repairs and dike maintenance would damage riparian vegetation and brush along dike tops and banks. No restoration of natural flow of the Nisqually River would occur because all existing dikes would remain.

Effects to Upland Habitat

Existing dikes would be repaired and maintained, and no effects on current upland habitats within the diked area, including forests, pasture lands, or developed areas, are expected. Some limited fertilizing, discing, plowing, and reseeding of non-native grasslands would be conducted, in addition to the haying and mowing program. These techniques would encourage non-native pasture grass over weed species in limited areas. A long-term goal to re-establish a native conifer-dominated forest is currently being implemented on the West Bluff parcel and would continue under all alternatives. The establishment of this forest would reduce erosion from this West Bluff parcel into McAllister Creek.

Effects to Native, Exotic, and Invasive Plants

Vegetative communities of the Refuge would continue under this alternative, although there is the potential of an increased acreage of exotic species such as reed canary grass and Himalayan blackberry. Habitat conditions within the dike are already changing as reed canary grass dominance increases. Control measures within the diked area would be minimal due to the size of the management area, feasibility of access in a moist soil environment, freshwater supply limitations, limited effectiveness of flooding to prevent regrowth, and concerns about widespread herbicide use within the Refuge; these measures would be limited in their beneficial effects. It is expected that the spread of exotic species would be a constant challenge and lead to the deterioration of freshwater wetland conditions, as well as decreased wildlife habitat function.

Although cordgrass is not present on the Refuge, it is spreading in coastal Washington and portions of north Puget Sound. This alternative does not include any actions that would change the potential for establishment of this species.

4.2.1.2 Refuge Expansion

Effects to Estuarine, Freshwater Wetland, Riverine and Riparian, and Upland Habitats

Under status quo conditions, no expansion of the Refuge boundary would occur. Areas outside the existing boundary would not be brought under Service protection or management. Indirect benefits to these habitats would occur if efforts to strengthen watershed protection through partnerships outside of the Refuge boundary were successful.

Efforts to acquire in-holdings within the existing boundary would continue, as would plans to develop and implement a Cooperative Agreement with the Nisqually Indian Tribe for the Service to manage properties owned by the tribe on the east side of the Nisqually River as part of the Refuge. In-holdings and tribal properties include estuarine habitats and some areas that are being restored to estuary, and Refuge protection and support of these areas would be beneficial to their long-term conservation. In-holdings along the west side of McAllister Creek include riparian habitat. Refuge acquisition and management of these parcels would be beneficial to their long-term conservation. Indirect benefits to riparian habitats would occur if efforts to strengthen watershed protection through partnerships outside of the Refuge boundary were successful.

4.2.1.3 Public Use Program

Effects to Estuarine, Freshwater Wetland, Riverine and Riparian, and Upland Habitats

Some aspects of the public use program would continue to have limited or short-term effects on habitats. Trails would be cleared or brushed out periodically. Herbicides would be used on a very limited basis to keep public facilities maintained. Boardwalks would shade limited portions of freshwater wetlands, dike banks, and grasslands. Dikes that also support trails would periodically be mowed, brushed, or graveled. Shellfishing and fishing would result in disturbance to the habitat caused by foot traffic or digging activity on mudflats, aquatic plants, and nearby salt marshes. Boat anchoring and foot traffic associated with various recreational activities such as unauthorized hunting may cause trampling in salt marsh areas. Eelgrass bed scarring may occur as a result of boat propeller or anchor damage that cuts eelgrass roots, stems, and leaves (Sargeant et al. 1995). Potential erosion of salt marsh areas caused from boat and PWC wakes would continue.

4.2.2 Alternative B

4.2.2.1 Habitat Restoration

Estuarine Habitat

A limited amount of estuarine restoration would occur under Alternative B. Approximately 318 acres of the diked area would be restored to a muted tidal condition by creating breaches in the dike in select locations. In addition, approximately 140 acres of the diked area would be fully restored to intertidal conditions by removing dikes in the north half of the Shannon Slough area

along McAllister Creek. Approximately 9,500 feet of exterior dike would be constructed, the largest amount of all action alternatives. Alternative B would benefit the estuarine habitats of the Refuge by expanding the amount of this habitat type. Although the exact types and conditions of estuarine habitats resulting from a muted tidal condition are more difficult to predict than if dikes were completely removed, several generalizations can be made (ENSR 1999):

- If dike breaches are sized to be at least as large as the natural channels that historically carried water in and out of intertidal areas, it is possible to obtain full tidal penetration in restored areas. Undersized breaches would lead to less-than-full tidal flooding.
- Breaching dikes would not yield the same distribution of sediment and salinity as dike removal.
- Incomplete drainage and storage of water in unfilled borrow ditches and other depressions can occur when dikes are breached and not returned to grade and the borrow ditches are not filled. Topographic depressions inside the breached dike area could trap fish during low tide.

Borrow ditches also affect tidal channel formation by reducing the amount of hydraulic energy available to form and maintain the highly developed pattern of tidal channels associated with natural systems. This in turn results in less overall channel area, a reduced proportion of the estuarine habitat area connected to channels, and less channel edge (C.. Simenstad, pers. comm). These factors reduce the ability of restored estuarine habitats to provide functions for fish and wildlife comparable to those of natural systems.

The distribution and species composition of vegetation in estuarine habitats are strongly influenced by physical factors, including the period of inundation and salinity (Burg et al. 1980). Exposure to wave energy, sediment supply, and the counterbalancing forces of erosion and accretion also strongly influence marsh distribution. Therefore, objectives to restore natural habitat conditions would not be fully met by this alternative.

The area of north Shannon Slough to be fully restored to tidal influence would provide the estuarine habitats that are the goals of restoration actions. However, this area would remain separated from the Nisqually River and the associated freshwater discharge and river-borne sediments. Shannon Slough itself would remain fragmented. The lower portion of this historic tidal channel would be connected to the estuary; however, the upper portion would remain detached, separated by a dike and tide gate system. There may also be reduced circulation in portions of this area due to the backwater effect caused by the new exterior dikes and limited tidal prism or volume restored. The configuration of this restoration area could also alter patterns of sedimentation due to its small size and the presence of dikes on three sides.

Estuarine habitats would be enhanced by increasing the total estuarine habitat area and tidal flow. Any increases in the areal extent of marsh vegetation cover would increase total primary productivity, as well as increase availability and distribution of detrital (decaying plant matter) material. Detritus is a key ingredient in estuarine habitat food webs, including those that support prey resources important to juvenile salmon (Naiman and Sibert 1979; Northcote et al. 1979).

Effects to Freshwater Wetland Habitat

Under Alternative B, approximately 45% (458 acres) of the currently diked area of freshwater wetland habitat would be restored to estuarine habitat. In the northern portion of the currently diked area, 318 acres of freshwater wetland would be restored to muted tidal conditions. Much of this area is currently dominated by reed canary grass. The northwestern portions of the diked area have a higher proportion of seasonal wetlands due to lower elevations and greater saltwater influence caused by seepage through the dikes. However, in the northeastern part of this area, there are areas of higher ground that currently support a mixed forest and scrub-shrub community. Based on the elevation of these areas (3.5 to 4.5 feet National Geodetic Vertical Datum [NGVD]) relative to reference areas outside of the dikes, these trees and shrubs are predicted to die back after dike breaching due to saltwater inundation. Similarly, the 140-acre area near the northern portion of Shannon Slough where dike removal is proposed would change after tidal influence is restored. Existing vegetation communities would be eliminated, including reed canary grass and other grasses prevalent in low areas, as well as shrubs that persist in areas of higher ground and dikes. Historic tidal slough systems that currently provide permanent freshwater channels within the dikes would revert to tidal sloughs. Freshwater wetland plants and submerged aquatics would be eliminated.

New internal dikes would be built to improve freshwater wetland management in the remaining 542-acre diked area. This would provide benefits to this habitat type, as reed canary grass growth would be more effectively managed. A mixture of native vegetation communities in seasonal wetlands and grasslands would be created in this area, modeled after existing ponds on the Refuge with high bird use. Other than riparian shrubs planted along sloughs and the edges of wetland areas, very little scrub-shrub habitat would be created or maintained. However, due to the large size of management units and freshwater supply limitations, the effectiveness of management actions may be limited, including the ability to flood large areas to depths sufficient for vegetation control. Reed canary grass and non-native pasture grasses would continue to dominate areas that could not be intensively managed, including the edges of some seasonally flooded marshes and ponds.

Effects to Riverine and Riparian Habitats

As no active restoration of riverine and riparian habitats is included under Alternative B, effects to these habitats would be the same as under Alternative A. The dike along the Nisqually River would continue to be maintained, confining the river and its associated habitats to the current location.

Effects to Upland Habitat

In general, implementation of this alternative would likely have little, if any, effect on existing upland habitats because the areas to be restored are largely freshwater wetlands. Exceptions would occur along a portion of McAllister Creek where brush habitat lining the dike banks would be lost due to dike removal. Trees and brush along internal road banks that are removed or restored in the currently diked area would also be lost. New native trees, shrubs, and herbaceous vegetation would be planted or seeded along the new exterior and interior dikes,

which would provide new brush habitat, screening, and also protect new dikes from erosion. Effects to the West Bluff parcel would be the same as Alternative A.

Effects to Native, Exotic, and Invasive Plants

Vegetative communities of various habitat types on the Refuge would still occur under this alternative. The proportion of estuarine habitat vegetation on the Refuge would increase because of the proposed estuarine restoration. Reed canary grass and blackberry would be expected to be eliminated in full estuarine restoration areas and largely controlled in muted tidal areas. The exact types and conditions of estuarine habitats that would result from a muted tidal condition are more difficult to predict than under complete dike removal (see Effects to Estuarine Habitats, above). Therefore, objectives of restoring natural vegetative communities may not be fully met by this alternative, where dike breaching (as opposed to dike removal) may lead to a deviation from natural conditions for these physical factors. Since this alternative would increase the acreage of estuarine habitat, the potential areas for *Spartina* spp. to become established are increased. Therefore, monitoring efforts would be needed to ensure that *Spartina* spp. does not become established on the Refuge.

Management of the remaining diked area would improve with the construction of new internal dikes that would allow more effective control of reed canary grass. A mixture of native vegetation communities and water depths could be created in this area. However, due to the large size of the management units and freshwater supply limitations, the effectiveness of management actions may be limited, including the ability to flood large areas to depths sufficient for vegetation control.

4.2.2.2 Refuge Expansion

Effects to Estuarine, Freshwater Wetland, Riverine and Riparian, and Upland Habitats

The expanded Refuge boundary under Alternative B would allow for acquisition and increased habitat protection for the upland forest and shrub habitats in the East Bluff area. If acquired, future development and associated loss and/or degradation of these habitats would be prevented and reforested where needed. A continuous corridor of protected forested habitat would potentially be established, improving riparian habitat quality below the bluff and adding to the diversity of Refuge habitats.

Inclusion of a limited amount of riparian habitat south of I-5 would allow for some improvements in habitat protection and restoration. Specific habitats affected would depend on areas acquired and protected and could include vegetated areas of riparian forest, scrub-shrub, and emergent (wetland) habitats, as well as unvegetated portions of the river channel and floodplain, including gravel beaches and bars. For example, riparian restoration, improved vehicle traffic management in riparian forest, and increased enforcement of the riparian area in Trotter's Woods could reduce habitat damage caused by unregulated public access and the existing network of dirt roads and trails in the riparian corridor. This would have little or no direct effect on estuarine and freshwater wetland habitats. Indirect effects would include

benefits associated with maintaining existing bluff slope stability, as well as improved integrity of riparian and upland corridors adjacent to estuarine habitats.

Expansion south of I-5 in the lower Nisqually Valley could provide extensive freshwater restoration opportunities, including seasonal wetlands and riparian corridors along sloughs and creeks, such as the upper portion of McAllister Creek. Seasonal wetland restoration projects on former agricultural lands would be very similar to those conducted on current Refuge lands within the diked area. For example, seasonal wetlands west of the headquarters area were enhanced in 2001 by mowing dense reed canary grass areas, discing, sculpting new depressions and seasonal ponds, and seeding, followed by flooding during the fall and winter months, greatly enhancing waterfowl habitat. Depending on the areas acquired and acquisition timing, restoration of freshwater wetlands could reduce the effects from the conversion of freshwater wetlands back to estuarine habitat north of I-5 and could increase the size and complexity of wetland habitats in the lower watershed. However, if this occurs it may be many years in the future.

In addition, upland habitats could benefit from improved management and enhancement. Specifically, if areas of upland pastureland or grassland south of I-5 were acquired, protection and improved management for wildlife could offset conversion of grasslands back to estuarine habitat north of I-5. The opportunity to restore estuarine habitats is limited to the area north of I-5, but substantial options for upland and freshwater wetland restoration and protection are possible south of I-5.

Acquisition of in-holdings and the development of a Cooperative Agreement with the Nisqually Indian Tribe would occur as described under Alternative A.

4.2.2.3 Public Use Program

Effects to Estuarine, Freshwater Wetland, Riverine and Riparian, and Upland Habitats

Effects of the public use program under Alternative B are similar to those described under Alternative A. However, the retention of dikes to support trails would have a larger effect on habitats in this alternative, by restricting restored estuarine habitat to primarily a muted system. Since this alternative would breach dikes and construct bridges to maintain the trail system, Refuge objectives to restore natural habitat conditions would not be fully met because of reduced physical processes that are required to build tidal systems (see also sections on physical factors and habitat for Alternative B above and habitat for Alternative C below).

Closure of the RNA to all consumptive uses and winter boat use would reduce localized effects of shellfishing, hunting, fishing, boat propellers, anchoring, and foot traffic on algae and submerged aquatic plants. The enforcement of no hunting areas would reduce some effects to salt marsh and mudflat areas on Refuge lands currently frequented by hunters. All action alternatives would reduce potential erosion of salt marsh caused by watercraft wakes. Alternative B would serve the largest number of students in the EE program. Some localized trampling of vegetation would occur as part of the enlarged program; however, study site locations would be selected to minimize effects to sensitive habitats.

A new bank fishing area would be developed in the Trotter's Woods area, if acquired. Some effects on riparian habitats would occur from vehicle parking areas and foot traffic, but this is expected to be less than present conditions because of planned improvements in access, such as controlling vehicle use.

4.2.3 Alternative C

4.2.3.1 Habitat Restoration

Effects to Estuarine Habitats

Alternative C would restore approximately 50% (515 acres) of the currently diked area to estuarine habitat, an additional 57 acres more than Alternative B.

Perhaps of greater significance are qualitative improvements in the condition of the restored area. Unlike Alternative B, which would retain large sections of the dike to allow for continued use of dike-top trails, Alternative C would remove the dike to grade in restoration areas. Therefore, the tidal connection between restored areas and the Nisqually River delta would be complete, with no possibility that "muted" tidal conditions would develop. Unimpeded tidal hydrology would increase the probability that restored estuarine habitats would function like natural systems by providing more natural physical conditions, including tidal hydrology, sediment distribution, and salinity patterns (ENSR 1999).

Removal of the dike along the lower portion of the river would allow the river channel to migrate naturally across the floodplain and through the restored area, a substantial benefit to estuarine habitats compared to Alternative B. No longer constrained to the existing channel by dikes, freshwater from the Nisqually River would be discharged across a larger area. This would allow for a natural distribution of river-borne sediments and a more variable salinity regime (ENSR 1999). These more natural physical conditions would provide for a wider distribution of river-borne sediments that help build and maintain elevations suitable for plant growth, and for distribution of diverse estuarine habitats throughout the delta. The river could also deliver large woody debris to estuarine habitat, increasing habitat structure and diversity. As with Alternative B, an increase in estuarine marsh would enhance functions of existing habitats by increasing availability and distribution of detrital material.

One drawback of Alternative C, relative to Alternative B, is a limited amount of restoration along the western margins of the diked area. Specifically, the Shannon Slough system would remain diked, reducing the amount of historical tidal channel habitat restored along McAllister Creek. McAllister Creek would remain relatively confined in a narrow area for approximately one-half of its length below the bridge at I-5. This alternative would result in an area of fully restored habitat that is largely constrained to the area immediately south of the existing outer dike face.

Effects to Freshwater Wetland Habitat

Alternative C would concentrate 515 acres of estuarine habitat restoration in the northern portion of the currently diked area. Freshwater wetlands in this area would be converted to tidal conditions, changing the current habitat functions. The converted area currently includes areas of a mixed forest and scrub-shrub community, seasonal wetlands, former pasturelands, and areas dominated by reed canary grass. Dikes would be removed instead of breached, allowing for a full tidal connection, increasing the probability that any existing vegetation, including trees and shrubs on higher ground and reed canary grass, would be displaced by estuarine habitat types such as salt marsh and mudflats. Management of freshwater wetland management units would be the same as described for Alternative B, resulting in similar effects. However, since Alternative C would have a slightly smaller area of freshwater wetlands (447 acres as opposed to 542 acres), water management would be easier; thus, the proportion of seasonal wetlands would be higher than grasslands and scrub-shrub habitats.

Effects to Riverine and Riparian Habitats

Implementation of Alternative C would restore 38 acres of riparian forest habitat along the Nisqually River, immediately north of the Twin Barns area. However, the dikes to the east and north of this area may be removed or lowered (graded) substantially to restore a natural flow to the Nisqually River. Riparian vegetation on this portion of the dike and its banks, including many large trees, would be removed or damaged by this activity. Riprap (rock) placed along the river levee in the past to repair dike breaches and weak spots would also be removed.

It is expected that much of the riverine and riparian habitat along the Nisqually River would be sustained and benefitted following restoration in Alternative C. Erosion would most likely be reduced in high flow or flood events because the river would be able to move freely rather than have all the energy restricted within a diked channel. In some cases farthest downstream, trees may be lost due to the marine influence and increased salinities from Puget Sound. However, an equilibrium would eventually be reached between saltwater and the large freshwater flows coming down the river, maintaining much of the existing riparian habitat.

Effects to Upland Habitat

Alternative C would enlarge the area of estuarine restoration and extend it farther south into the currently diked area. The vast majority of this area is a mosaic of wetland types and pasture land. Tidal inundation would eliminate these pastures and convert them to estuarine habitats.

More brush habitat along the McAllister Creek Dike would be lost due to dike removal in Alternative C, compared to Alternative B. Trees and brush along internal road banks that are removed or restored in the currently diked area would also be lost. New native trees, shrubs, and herbaceous vegetation would be planted or seeded along the new exterior and interior dikes, which would provide new brush habitat and screening, as well as protect new dikes from erosion. Effects to the West Bluff parcel would be the same as described in Alternative A.

Effects to Native, Exotic, and Invasive Species

Implementation of this alternative would restore approximately 50% of the diked area to estuarine habitat. Complete tidal connection between restored areas and the Nisqually River delta would occur. Unimpeded tidal hydrology would increase the probability that restored estuarine habitats would function like natural systems by providing more natural physical conditions, including tidal hydrology, sediment distribution, and salinity patterns. As a result, reed canary grass and blackberry would likely be eliminated in the restored area. The potential effects of *Spartina* spp. introduction and establishment would be the same as described under Alternative B, but with more acreage available for potential establishment.

Management of freshwater wetland management units would be the same as for Alternative B, resulting in similar effects. However, Alternative C would have a slightly smaller area of freshwater wetlands (447 acres compared to 542).

4.2.3.2 Refuge Expansion

Effects to Estuarine, Freshwater Wetland, Riverine and Riparian, and Upland Habitats

Effects to Refuge habitats would be the same as described under Alternative B.

4.2.3.3 Public Use Program

Effects to Estuarine, Freshwater Wetland, Riverine and Riparian, and Upland Habitats

Effects of the public use program described under Alternative B also apply to Alternative C, without the effects associated with dike retention. Additional effects include the following. A boardwalk would be installed along McAllister Creek, extending along the northwest side of the estuarine restoration area. The boardwalk would create some shading along its length, disturbing plant growth, but effects on habitat would be very localized. Boardwalk installation may have some short-term effects on estuarine habitats from soil disturbance and trampling. However, these would be minimized through the use of a pinned foundation boardwalk. Pinned foundation boardwalks use concrete blocks that are pinned in place to support the boardwalk, eliminating the need to drive pilings into soils.

The new trail east of the Nisqually River would be designed to minimize effects on habitat, including boardwalk sections that would be required in estuarine restoration areas. Effects of the new Refuge hunting area would include foot and boat traffic in mudflats and salt marsh habitats within the largest hunting area of all alternatives. However, effects would be eliminated in closed areas, especially McAllister Creek, and reduced by the 3 day per week restriction. Some localized trampling of vegetation would result from new study sites in the enlarged environmental education program; however, study site locations would be selected to minimize effects to sensitive habitats.

4.2.4 Alternative D (Preferred Alternative)

4.2.4.1 Habitat Restoration

Effects to Estuarine Habitat

Alternative D represents the largest area of restoration under consideration in this CCP. Approximately 699 acres (70% of the currently diked area) would be restored to full tidal influence by removing large sections of the outer dike to grade. This alternative is most similar to Alternative 6, 70% estuarine restoration, described in the hydrological modeling study (ENSR 1999). This alternative would lead to an additional 184 acres of restored habitat as compared to Alternative C. Effects of removing dikes along the lower Nisqually River on estuarine habitats would be similar to those described under Alternative C.

Alternative D also significantly increases benefits to estuarine habitats in the vicinity of Shannon Slough and McAllister Creek in the western portions of the delta. Under this alternative, Shannon Slough would be fully restored to tidal influence. Dikes that might prevent the migration of the McAllister Creek channel, and the discharge of freshwater to the marsh during flood of the creek, would be removed. This alternative maximizes the range of physical conditions (e.g., salinity, elevation) within the area restored to tidal influence, leading to a more diverse and natural mix of estuarine habitats within the Nisqually delta.

Because Alternative D prescribes the largest contiguous area restored to tidal influence, it would increase the complexity and diversity of restored estuarine habitats, including producing more complex channel order and sloughs and greater elevational differences in the salt marsh mosaic. Alternative D would have the greatest benefit to existing estuarine habitats currently outside of the dikes by increasing tidal exchange, volume, and nutrient exchange to marshes north of the current dike, as well as along the length of McAllister Creek north of I-5.

Effects to Freshwater Wetland Habitat

Implementation of Alternative D would result in the largest conversion of freshwater wetland area to estuarine habitat. Approximately 263 acres of freshwater wetlands would remain after estuarine restoration is completed and a new exterior dike constructed. These would be located in the southeastern portion of the currently diked area. Existing freshwater wetlands in the northern half of the diked area, as well as the entire Shannon Slough area north of I-5, would be converted to estuarine habitat by full restoration of tidal influence (699 acres). Based on acreage, this would be the largest conversion of freshwater wetlands under consideration. Qualitatively, the effects would be similar to those described for Alternatives B and C. Tidal inundation would eliminate existing freshwater wetland vegetation communities. Most of this area is currently dominated by reed canary grass, but it also includes scrub-shrub and marsh communities. Higher elevation areas that currently support trees and shrubs would revert to salt marsh habitats. Lower areas, currently seasonally flooded and/or saturated and dominated by a mixed herbaceous community of grasses and forbs, would become unvegetated mudflats or low salt marsh. The Shannon Slough system would convert from permanent freshwater to tidally

influenced sloughs and channels. The permanent freshwater wetlands north of the headquarters buildings would remain.

As with the other action alternatives, Alternative D would require new internal dikes to improve freshwater wetland management options in remaining diked areas. The resulting management units would be smaller under this alternative and provide less total area of freshwater wetlands (263 acres). However, the size of these units would allow for more effective management. Limited freshwater supplied by the artesian wells would be applied to a smaller area, improving the ability to control reed canary grass. Higher quality freshwater wetlands with improved wildlife habitat functions would result.

Effects to Riverine and Riparian Habitats

With respect to effects on riparian and riverine habitats, habitat restoration in Alternatives C and D is similar, focusing on restoring 38 acres of riparian habitat along the Nisqually River. The primary differences between these two alternatives involve the amount of restoration on McAllister Creek and the Shannon Slough area, which would have little effect on the habitats on the east side of the delta. Effects related to riparian and riverine habitats are similar to those described under Alternative C.

Effects to Upland Habitat

Alternative D expands the estuarine restoration described under Alternative C, incorporating the Shannon Slough area all the way south to the Refuge entrance road. Given the relatively higher elevations in this portion of the currently diked area, there is a significant potential to affect existing upland habitat in this area. Areas currently managed as pasture land, and subject to periodic mowing or haying, probably contain a mix of seasonally flooded "wet meadow" wetlands and upland pasture land. Restoration of tidal influence in these areas would eliminate the pasture grass communities and reed canary grass. The higher elevation areas would most likely transition to salt marsh habitat more quickly than lower elevation areas, which would initially convert to mudflat habitat.

The brush habitat along the McAllister Creek dike would be lost during dike removal in Alternative D. Trees and brush along internal road banks that are removed or restored in the currently diked area would also be lost. New native trees, shrubs, and herbaceous vegetation would be planted or seeded along the new exterior and interior dikes, which would provide new brush habitat and screening and would also protect new dikes from erosion**.** Effects to the West Bluff parcel are the same as described under Alternative A.

Effects to Native, Exotic, and Invasive Plants

Effects of removing dikes along the lower Nisqually River on the vegetation community would be similar to those described under Alternative C. Since this alternative has the highest amount of acreage restored to estuarine habitat, the potential for *Spartina* spp. establishment would be the largest. Monitoring efforts would need to be the greatest to ensure early detection and control.

As with the previously described action alternatives, Alternative D would entail building new internal dikes to improve freshwater wetland management options in the remaining diked areas. The resulting management units would be smaller under this alternative and provide less total area of freshwater wetlands (263 acres). However, the size of these units would allow for more effective management. Limited freshwater supplied by the artesian wells would be applied to a smaller area, improving the ability to control reed canary grass. Higher quality freshwater wetlands with improved wildlife habitat functions would result, similar to habitat improvement projects completed in 2000 and 2001 in the headquarters area.

4.2.4.2 Refuge Expansion

Effects to Estuarine, Freshwater Wetland, Riverine and Riparian, and Upland Habitats

Alternative D includes the largest expansion of the Refuge boundary. Acquisition of in-holdings and development of a Cooperative Agreement with the Nisqually Indian Tribe would occur as described under Alternative A. No additional estuarine habitat would be included in this alternative for expanding the Refuge boundary, limiting the direct effects to estuarine habitats. However, the proposed area of expansion would include areas where the freshwater wetland management capabilities of the Refuge could be further developed. Should the Service be able to acquire manageable properties, a larger, more diverse complex of wetland habitats would result, contributing to an overall improvement in watershed conditions. Therefore, implementation of Alternative D could indirectly benefit estuarine habitats at the Refuge.

Alternative D includes a larger expansion of riparian habitat than Alternatives B and C, including a portion of the Nisqually River corridor. Specific habitats affected would depend on areas acquired and protected, and could include vegetated areas of riparian forest, scrub-shrub and emergent (wetland) habitats, as well as unvegetated portions of the river channel and floodplain, including gravel beaches and bars. Active management and restoration of the riparian area could reduce habitat damage caused by unregulated public access and the existing network of dirt roads and trails in the riparian corridor. This would have little or no direct effect on estuarine habitats. Indirect effects would include benefits associated with maintaining existing bluff slope stability, as well as improved integrity of riparian and upland corridors adjacent to estuarine habitats.

Alternative D includes the largest plan for expansion of the Refuge boundary and would have the potential to enhance or restore the largest amount of freshwater and riparian wetland habitat of all the alternatives. Similar to Alternatives B and C, extensive freshwater restoration opportunities could result. Depending on the areas acquired and acquisition timing, restoration of freshwater wetlands south of I-5 could reduce the effects from the conversion of freshwater wetlands to estuarine habitat north of I-5 and could increase the size and complexity of the wetland habitat mosaic in the lower watershed. However, if this occurs it may be many years in the future. As described in Alternative B, wetland restoration of agricultural lands could include periodic mowing, discing, sculpting, seeding, and flooding in the fall and winter months. This alternative would potentially provide additional protection for floodplain and riparian forest in the Nisqually Valley that is not included in Alternatives B or C. Riparian restoration south of I-5 would enhance McAllister Creek water quality and benefit invertebrates, fish, waterbirds, and marine mammals. Improved water quality would be especially beneficial to shellfish found near

the mouth of the creek (Dickes 2002). Combined with the greater potential for riparian protection and restoration, this alternative for Refuge boundary expansion could provide the greatest long-term benefit to freshwater wetlands.

Similar to Alternatives B and C, direct benefits for upland habitats could result. Specifically, this alternative proposes the acquisition of the largest amount of upland bluffs. If areas of upland pasture land or grassland south of I-5 were acquired, protection and improved management for wildlife could reduce the effects of the conversion of grasslands back to estuarine habitat north of I-5. Whereas the opportunity to restore estuarine habitats is limited to the area north of I-5, substantial options for upland and freshwater restoration and protection may be possible south of I-5.

4.2.4.3 Public Use Program

Effects to Estuarine, Freshwater Wetland, Riverine and Riparian, and Upland Habitats

Effects of boardwalk construction are similar to those described for Alternative C. All other effects–from closure of the RNA to boating, fishing, and shellfishing–are the same as described in Alternative C. Effects from the hunting area would be slightly less than in Alternative C because of the smaller acreage, but effects to habitats along McAllister Creek would continue. This alternative potentially includes new accessible fishing site locations at the Nisqually River or Luhr Beach, if acquired. These sites would most likely involve construction of small platform sites that contain all activities. Construction of these platforms would be conducted with minimal disturbance to adjacent habitats.

4.2.5 Effects to Regional Availability of Wetland Habitats

A specific analysis was done to better understand how estuarine restoration and freshwater conversion at Nisqually NWR would affect the larger south Puget Sound area (Tanner 1999). This discussion focuses on the effects of habitat restoration only within the current Refuge boundary in a regional context. Due to the large area of Nisqually NWR wetlands, and the significant shift in wetland habitat types that would occur if restoration of estuarine habitat is implemented, the regional context of the alternatives was considered (Table 4.2-1). Using historical data on the estimated distribution of estuarine habitats (Bortelson et al. 1980) and National Wetland Inventory (NWI) data on current wetland distribution, a geographic information system (GIS) analysis was completed and is summarized here. For this analysis, a definition for the region of south Puget Sound consistent with that used by the WDFW for salmonid stock management was used (see Tanner [1999] for further information on project boundaries and methods). This area extends north to the Cedar/Sammamish Water Resource Inventory Area (WRIA) in King County, west to Kennedy/Goldsbourough WRIA in Mason County, east to Duwamish and Puyallup WRIAs in Pierce County, and south to the Nisqually WRIA in Thurston County.

Table 4.2-1. Summary of Habitat Restoration Effects to Regional Estuarine and Freshwater Wetlands.

Alternative	Estuarine Habitat Restored (acres)	% Loss of Regional Freshwater Wetlands	% Gain of Regional Estuarine Habitat
A (Status Quo)	0	0.0%	0.0%
B – Minimum Estuarine Restoration	458	1.7%	30.0%
C – Moderate Estuarine Restoration	515	1.9%	33.7%
D – Maximum Estuarine Restoration	699	2.6%	45.7%

Nisqually River delta estuarine (intertidal and subtidal) habitats have decreased from 6,207 acres historically to an estimated 5,016 acres currently. Especially significant has been the loss of intertidal emergent habitat (high and low salt marsh), which has declined from 1,458 acres to 674 acres, a loss of 54%. Much of this loss is associated with diking and the conversion of estuarine habitats to palustrine (freshwater) wetlands inside the dike system (Tanner 1999). Palustrine wetlands comprise a substantial portion (18%) of the remaining wetlands in the south Puget Sound region. Emergent marshes comprise the largest single class of palustrine wetlands. Estuarine intertidal wetlands are much less prevalent in the region and comprise only 6% of non-upland areas. The vast majority of the estuarine intertidal area is comprised of unvegetated mudflats and beaches. Estuarine marsh habitat (salt marsh) is relatively scarce in south Puget Sound; approximately 1,529 acres account for 0.3% of the non-upland area in this region.

Freshwater wetlands are an important resource in south Puget Sound and continue to be threatened by incremental loss and degradation. Estuarine wetlands, historically less abundant, are becoming increasingly rare throughout Puget Sound, and opportunities for restoration of estuarine wetlands are limited. The Nisqually River delta historically contained more than twice the current amount of this wetland type. Restoration of intertidal wetlands at Nisqually NWR could produce a substantial increase in the amount of salt marsh in south Puget Sound, with a relatively small reduction in freshwater habitats in the region. From a regional perspective, estuarine restoration in the Nisqually delta would provide a significant increase in this habitat type, with important benefits to fish and wildlife resources throughout south Puget Sound and beyond. Implementation of Refuge boundary expansion alternatives south of I-5 could also reduce the effects of freshwater wetlands calculated within the diked area in this analysis.

4.3 Effects to Fisheries Habitats and Resources

The discussion of the effects of the alternatives on fish species focuses on the selected species described in the Affected Environment chapter (Table 3.3-1). These estuarine and anadromous fish species are of management concern in the study area and all depend upon estuarine habitats to some degree. These species are meant to represent what could happen to the broader set of fish species inhabiting the Refuge.

Both long-term and temporary effects to fish species may occur in association with each alternative. Temporary effects to fish species are identified as effects from construction activities, such as dike removal, road maintenance, and channel modification associated with estuarine restoration. Long-term effects to fish species may occur through changes in habitat abundance and diversity and changes in primary production and consequently the food chain. The following describes the potential long-term and temporary effects to various fish species that may occur in association with each alternative.

Effects to fish species listed in Table 3.3-1, Chapter 3 are discussed in this chapter. Species other than Pacific salmon are discussed collectively as "Forage Fish and Other Fishes" since these species all depend upon the nearshore marine environment.

4.3.1 Alternative A

4.3.1.1 Habitat Restoration

Effects to Pacific Salmon

Estuaries are among the most productive ecosystems on Earth (Odum 1971) and are critical habitat for juvenile Pacific salmon stocks (Levy et al. 1979; Levy and Northcote 1981; Simenstad et al. 1992). They offer juveniles abundant food sources, refuge from predators, and the ability to acclimate to higher salinities. Estuaries not only afford rich feeding and growth opportunities, but also allow fry to delay out-migration until population blooms of marine zooplankton prey occur, which can double fry survival to adulthood (Salo 1991). Optimal estuarine conditions are critical for those anadromous salmonid stocks that have evolved a dependence on the estuary for juvenile rearing. Upon return from the ocean, adult salmonids often hold in estuarine environments for some time while sexually maturing and adjusting to lower salinities (Olson 1989).

Under Alternative A, no estuarine habitat would be restored. Since all of the Pacific salmon found in the Nisqually Basin depend upon estuarine habitats to some degree, especially juvenile chinook and chum salmon (Dorcey et al. 1978; Healey 1982; Simenstad et al. 1982), there would be no expected increase in salmonid populations under this alternative. In addition, there would be no indirect benefits to these species, resulting from improvements or restoration of existing habitats to tidal conditions as would occur under the action alternatives. The existing estuarine habitats would continue to deteriorate under existing management. The dike would be maintained, continuing to interrupt tidal channels and reducing the tidal prism, water volumes,

and nutrient exchange in the existing estuarine habitats. Any diking of tidal channel habitat reduces the rearing capacity of an estuary. The reduced tidal prism and water volume associated with diking creates a less complex system by limiting the creation of smaller channels and slough branches, resulting in less habitat for fish (Thom et al. 1985).

Effects to Forage Fish and Other Fish

Effects to Pacific herring, surf smelt, Pacific sand lance, and other estuarine-dependent species under Alternative A are similar to those described for Pacific salmon. These species depend upon the nearshore marine environment and estuaries for spawning or rearing, or both. Alternative A would not increase foraging or rearing habitat preferred by these species, nor increase spawning habitat.

As described in Section 3.3. little is known about the current status of the bull trout in the Nisqually River system (WDFW 1998). Effects to bull trout in this alternative are the same as described above for Pacific salmon.

4.3.1.2 Refuge Expansion

Effects to Pacific Salmon, Forage Fish, and Other Fishes

There is no Refuge expansion proposed in this alternative, so no effects would be expected.

4.3.1.3 Public Use Program

Effects to Pacific Salmon, Forage Fish, and Other Fishes

This alternative does not propose any major changes in the public use program on the Refuge. Therefore, fish populations on the Refuge would not be affected.

4.3.2 Alternative B

4.3.2.1 Habitat Restoration

Effects to Pacific Salmon

Compared to Alternative A, Alternative B would provide some benefits to the anadromous and estuarine-dependent fish species in the Nisqually River, Estuary, and Reach. Restoration of the estuary under this alternative is expected to result in some increased primary production and consequent food chain support for fish species that depend upon estuarine and shallow marine habitats for survival.

Under Alternative B, a muted tidal condition would be created by breaching the dike in specific locations. There may be temporary, negative effects on Pacific salmon from increased turbidity due to dike breaching, channel modification, and bridge construction. Borrow ditches and other

unnatural drainage features would not be filled and could lead to the development of a less complex channel system. This would result in less overall channel area, a reduced proportion of the estuarine habitat area that is connected to channels, and less channel edge (C.. Simenstad, pers. comm). Dike breaching, as opposed to dike removal, may result in a deviation from natural conditions for physical factors that influence the distribution and species composition of vegetation in estuarine habitats. Borrow ditches would likely pond water between tides (ENSR 1999), which may entrap fish. Topographic depressions inside the breached dike area could also trap fish during low tide if not connected to tidal channels. Unlike Alternatives C and D, the dike along the lower portion of the Nisqually River would remain intact. The fully restored area north of Shannon Slough would remain fragmented and separated from the Nisqually River and associated freshwater discharge and river-borne sediments that help build and maintain elevations suitable for plant growth. Therefore, muted estuarine areas of this alternative would not benefit salmonid populations as much as fully functioning restoration alternatives.

Effects to Forage Fish and Other Fishes

Compared to Alternative A, Alternative B would provide some benefits to forage fish and other fish species dependent upon estuarine habitats. This alternative would likely increase the amount of mudflats, a habitat preferred by juvenile and adult starry flounder, juvenile English sole, juvenile and adult Pacific staghorn sculpin, and all life-stages of arrow gobies. This alternative is the only action alternative that retains the dike along the lower portion of the Nisqually River, causing the restored area to remain fragmented and separated from the Nisqually River. This would result in less habitat for spawning and rearing of young starry flounder and less rearing for juvenile English sole than under Alternatives C and D. As with Pacific salmon, temporary effects to forage and other fishes would occur (see above).

4.3.2.2 Refuge Expansion

Effects to Pacific Salmon

Compared to Alternative A, the increased protection of Nisqually River, McAllister Creek, and associated tributaries in Alternative B would benefit salmon in the long term by protecting important spawning and rearing habitat and migrational corridors. If appropriate sites are acquired along the river or creek, riparian or wetland restoration could contribute to improved salmon habitat quality.

Effects to Forage Fish and Other Fishes

Increased protection of Nisqually River, McAllister Creek, and associated tributaries would likely not affect forage fishes but may benefit Pacific staghorn sculpin and starry flounder, which spawn and rear in rivers.

4.3.2.3 Public Use Program

Effects to Pacific Salmon

This alternative would allow the Service to manage a current bank fishing location on the Nisqually River (Trotter's Woods) and potentially create an accessible fishing site at Luhr Beach boat ramp. Nisqually River coho, chinook, and chum salmon and steelhead are co-managed by the State of Washington and the Nisqually Indian Tribe to achieve specific objectives (exploitation rate, escapement, or quota). Harvest-related effects to these stocks associated with an increase in sport fishing opportunity would be estimated and taken into consideration in the development of annual pre-season fishing agreements and associated regulations**.** Following post-season analyses and reporting of catch records, any adjustments in fishing regulations needed to achieve the desired management objectives for each stock would be made. Thus, effects to Pacific salmon associated with development of additional bank fishing opportunities would be negligible.

Effects to Forage Fish and Other Fishes

The creation of new bank fishing locations along the Nisqually River is not expected to affect these fish species.

4.3.3 Alternative C

4.3.3.1 Habitat Restoration

Effects to Pacific Salmon

Alternative C would restore 50% of the diked area to full estuarine habitat. The unimpeded tidal hydrology of the restored area under this alternative would increase the probability that restored estuarine habitats would function like natural systems. The removal of the dike along the lower portion of the river would allow the river channel to migrate naturally across the floodplain. This is expected to allow for a wider distribution of river-borne sediments that help build and maintain elevations suitable for plant growth and high salt marsh development. This would increase availability and distribution of detrital material to support the food chain, more so than Alternatives A or B. As in Alternative B, temporary adverse effects to Pacific salmon would occur from increased turbidity due to dike removal and channel modification.

Chinook Salmon

An assessment of primary critical habitat issues affecting chinook salmon in 15 Washington State watersheds concluded that estuarine loss was a limiting factor in 14 of the watersheds (Bishop and Morgan 1996). There are a number of factors controlling chinook salmon productivity in the Nisqually River, including ocean conditions, conditions in the estuary, harvest rates, and freshwater habitat effects. To develop comprehensive and integrated multi-species management plans for the Nisqually River basin, the Nisqually Indian Tribe analyzed environmental factors over multiple life history stages to determine current productivity and

prioritize recovery efforts (EDT Work Group 1999). The authors cited permanent protection and restoration of the estuary, which contains habitats critical to chinook salmon (an ESA-listed species), as one of three key factors for rebuilding salmon runs in the Nisqually Basin. Their analysis indicates that these actions in the estuary alone would double the natural production of fall chinook salmon in the Nisqually River and provide multi-species, as well as regional, benefits. Consistent with these observations is the conclusion of the draft Nisqually Basin Fall Chinook Recovery Plan that states "[t]op priorities for rebuilding natural fall chinook salmon production include restoration of the estuary..." (Nisqually Chinook Recovery Team 2001).

There is some evidence of utilization of restored estuarine areas by chinook salmon. Restored estuarine marsh habitat in the Fraser River and Puyallup River estuaries has been extensively used by juvenile chinook salmon (Levings and Nishimura 1997; Shreffler et al. 1990). Juvenile chinook salmon have accessed and utilized a created estuarine slough in the Chehalis River estuary (Simenstad et al. 1992). The diets of the fish indicate that likely sources of their prey are the sediments, marsh and marginal riparian vegetation, and channels. Based on the above studies, restoration of the Nisqually River Estuary under Alternative C would not only substantially increase available rearing habitat, but also offer off-channel refuge from high flows (floods) that could readily sweep fish out to marine waters before they are prepared to go.

Chum Salmon

Juvenile chum salmon, which reside in estuaries for a period of days to weeks, favor tidally influenced creeks through fresh and brackish water marshes, the confluence of major and minor distribution channels in the intertidal zone, and delta margins (Healey 1982). While chum salmon tend to spend less time in the estuary than subyearling chinook salmon, they still depend on the detritus-based food web that estuaries support (Sibert et al. 1977). Restored estuarine marsh habitat in the Fraser, Puyallup, and Snohomish River estuaries has been extensively used by juvenile chum salmon (Levings and Nishimura 1997; Shreffler et al. 1990, 1992.) Levings and Nishimura (1997) found that marked chum salmon fry resided in the restored marsh habitat as long as in undisturbed sites. Juvenile chum salmon have also accessed and utilized a created estuarine slough in the Chehalis River estuary (Simenstad et al. 1992).

Based upon the above studies, restoration of the Nisqually River Estuary, particularly under Alternatives C and D, would not only substantially increase available rearing habitat for juvenile chum salmon, but also offer off-channel refuge from high flows (floods) that could readily sweep fish out to marine waters before they are prepared to go.

Coho Salmon

Coho salmon are less able and take much longer to adapt to saline water than chum or chinook salmon (Crone and Bond 1976; Kennedy et al. 1976). Estuaries are important staging areas for coho salmon for the physiological transition needed when moving from fresh to saltwater. Downstream migrant coho salmon sub-yearlings that are unable to find suitable low salinity habitat may be forced to more brackish or marine waters, lowering their chance for survival.

Rapid growth of sub-yearling coho salmon in estuarine side channels of the Chehalis River has been reported (Miller 1993). Restored estuarine marsh habitat in the Chehalis River estuary and tidal fresh and oligohaline habitats in the Snohomish River have also been extensively utilized by juvenile coho salmon (Cordell et al. 1999; Simenstad et al. 1992). These restored sites have produced juvenile salmon prey organisms in densities that equaled or exceeded those at reference sites. Food habits of juvenile coho salmon in restored intertidal wetlands also appear to be similar to those occupying "natural" wetlands (Aitkin 1998).

Juvenile coho salmon utilize the Nisqually River Estuary during the spring and summer months; in a study conducted during 1980, the dominant prey item of juveniles was found to be sand lance (Pearce et al. 1982). An increase in forage fish abundance in the Nisqually Estuary due to estuarine restoration would likely benefit coho salmon. Based on the above studies, restoration of the Nisqually River Estuary under Alternative C would not only substantially increase available habitat for juvenile coho salmon to complete their transition from fresh to marine waters, but would also increase their forage base and offer off-channel refuge from high flows that could sweep fish out to marine waters before they are prepared to go.

Effects to Forage Fish and Other Fishes

Although there would be some temporary effects to fish from dike removal and channel modification (see above discussion in Pacific salmon), Alternative C would benefit the fish resources of the Nisqually River watershed. These benefits would exceed those offered by Alternative B, where a smaller extent of intertidal habitat restoration and muted tidal habitat restoration is considered. The unimpeded tidal hydrology of the restored area under Alternative C would increase the probability that restored estuarine habitats would function like natural systems. Under Alternative C, habitat for estuarine-dependent fish would be increased in both quantity and quality. This alternative would likely provide more foraging and rearing habitat preferred by these species than under Alternative A or B and may provide some spawning habitat for estuarine spawners.

Restoration of the estuary would increase primary production and consequent food chain support for nearly all fish species that depend on estuarine and shallow marine habitats for survival, including prey fish species preferred by bull trout. An increase in forage fish abundance in the Nisqually Estuary due to estuarine restoration would likely benefit bull trout. Based on field studies of bull trout in north Puget Sound, restoration of the Nisqually River Estuary under Alternative C would substantially increase available foraging and rearing habitat for juvenile, sub-adult, and adult bull trout (C. Cook-Tabor, pers. comm.).

4.3.3.2 Refuge Expansion

Effects to Pacific Salmon, Forage Fish, and Other Fish

Same as Alternative B**.**

4.3.3.3 Public Use Program

Effects to Pacific Salmon

Proposals to changes in bank fishing opportunities are similar to Alternative B, except for additional bank fishing locations on the Nisqually River, east of the river, and north of I-5. This would result in greater fishing opportunities on the Nisqually River. However, as described in Alternative B, harvest-related effects to salmon and steelhead stocks would be estimated and taken into consideration in the development of annual pre-season fishing agreements and associated regulations.

Forage Fish and Other Fishes

The creation of new bank fishing locations along the Nisqually River is not expected to affect these fish species.

4.3.4 Alternative D (Preferred Alternative)

4.3.4.1 Habitat Restoration

Effects to Pacific Salmon

Pacific salmon runs in the Nisqually River would benefit most under Alternative D, relative to all the alternatives. This alternative would restore 70% of the diked area to full estuarine habitat, creating larger, more complex estuarine system than any other alternative. Management actions under Alternative D would rehabilitate habitat-forming processes of the estuarine system that were degraded by the construction of the dike. Alternative D would produce the largest conversion of freshwater wetland area to estuarine habitats considered, as well as the largest increase in vegetated salt marsh habitat. Any increases in estuarine habitats with marsh vegetation cover would lead to increased total primary productivity, as well as increased availability and distribution of detrital material. Effects to chum, coho, and chinook salmon would be similar to those described under Alternative C, but would be substantially more beneficial in this alternative.

The removal of the dike along the lower portion of the Nisqually River would allow the river channel to migrate naturally across the floodplain. This would allow for a wider distribution of river-borne sediments that help build and maintain elevations suitable for plant growth, resulting in increased availability and distribution of detrital material. Detritus is a key component of estuarine habitat food webs, including those that support prey resources important to juvenile salmon and other fish species (Naiman and Sibert 1979; Northcote et al. 1979). Decomposing marsh plants release nutrients that would otherwise remain in the sediments (Dorcey et al. 1978). Invertebrates, important food resources for fishes, feed upon the decomposing marsh plants as they break up into organic particles or detritus.

Due to insufficient study or wide ranges in data on juvenile use of and benefit from estuarine rearing, it is not possible to accurately estimate the increased salmon production that would result from restoration of tidal function to the Nisqually River Estuary under the various alternatives. Monitoring efforts of a small estuarine restoration project on Red Salmon Creek, east of the Nisqually River, have documented presence of chinook salmon. In May 1999, 3 years after the former pastureland area was restored, 691 chinook salmon were observed (J. Dorner, pers. comm.). These data, as well as the research findings on the importance of estuarine rearing cited above, support the expectation that the estuarine restoration proposed in Alternative D would offer the most substantial benefit to the different populations. Restoration of the Nisqually River Estuary under Alternative D would not only substantially increase available rearing habitat but also offer off-channel refuge from high flows (floods) that could readily sweep fish out to marine waters before they are prepared to go.

Effects to Forage Fish and Other Fishes

Alternative D would offer a variety of benefits that are significant to the fish resources of the Nisqually River watershed, exceeding those offered by other alternatives. Habitat for estuarine-dependent fish would be greatly increased in both quantity and quality. Because of its parallel orientation relative to the river and floodplain, restoration in Alternative D would provide the greatest diversity of estuarine habitat types. Greater diversity would result from the range of elevations, salinity, and exposure, and the full mix of habitats that existed in the estuary historically would be provided long-term. On the other hand, Alternatives B and C would increase the amount of intertidal habitat in an east to west orientation across the face of the delta, and thus would not provide this same diversity in physical conditions and thus habitat types.

Anadromous bull trout would benefit most under Alternative D, followed by Alternatives C and B, because of an expected increase in forage fish abundance in the Nisqually Estuary due to restoration.

Pacific herring and surf smelt depend on the nearshore marine environment. All life stages of these species utilize Puget Sound estuaries. They spawn in intertidal or shallow subtidal waters at very specific locations throughout Puget Sound and rear in nearshore, shallow water areas (Emmett et al. 1991). Due to this dependence, Alternative D would be the most favorable for Pacific herring and surf smelt due to the creation of a larger, more complete and functional estuarine system. This alternative is the most likely to provide not only the most foraging and rearing habitat preferred by these species, but may also provide spawning habitat. Alternative C would be the next most favorable, for similar reasons, followed by Alternative B.

Although extensive studies documenting the utilization of restored estuarine habitats in Puget Sound by non-salmonids are not abundant, some examples are available. Starry flounder were found to utilize a wetland site restored to tidal inundation by breaching a dike in the Snohomish River estuary (Cordell et al. 1998). Due to the spawning and rearing requirements of starry flounder and English sole, Alternative D would be the most favorable for these species. This alternative would be the most likely to provide not only the most foraging and rearing habitat

preferred by these species, but may also provide more spawning habitat for starry flounders than currently exists.

Pacific tomcod, Pacific staghorn sculpin, shiner perch, and arrow goby would also benefit from estuarine restoration in Alternatives B to D. The increased total available habitat, primary production, and associated increase in detrital material under the action alternatives would expand the rearing habitat and foraging opportunities for these species over current conditions. In addition, an increase in estuarine habitat may provide more spawning habitat for arrow gobies and Pacific staghorn sculpin, both estuarine spawners. An increase in forage fish abundance likely to occur under the action alternatives would benefit the fish-eating fishes, such as adult Pacific tomcod and large Pacific staghorn sculpin. Pacific staghorn sculpin feed at high tide on mudflats (Love 1991) and have been found to utilize a created estuarine slough of the Chehalis River (Simenstad et al. 1992) and a wetland site restored to tidal inundation by breaching a dike in the Snohomish River estuary (Cordell et al. 1998). Shiner perch were also found to extensively utilize a created estuarine slough of the Chehalis River (Simenstad et al. 1992).

4.3.4.2 Refuge Expansion

Effects to Pacific Salmon

Effects would be similar to Alternative C, except the slightly greater protection of the Nisqually River corridor under Alternative D would provide even greater benefits.

Effects to Forage Fish and Other Fishes

Same as Alternatives B and C.

4.3.4.3 Public Use Program

Effects to Pacific Salmon

This alternative may create two or three new bank fishing locations on the Nisqually River, resulting in greater fishing opportunity. See Alternative B for a description of the associated harvest-related effects.

Effects to Forage Fish and Other Fishes

The creation of new bank fishing locations along the Nisqually River is not expected to affect these fish species.

4.3.5 Effects to Threatened and Endangered Species

4.3.5.1 Alternative A

Habitat Restoration, Refuge Expansion, and Public Use Program

This alternative would not increase the amount or quality of essential habitat of chinook salmon or bull trout. However, these species would benefit, although not significantly, from more uniform land protection and conservation within the Refuge. The increase in watershed-wide habitat protection under this alternative may increase water and intertidal habitat quality and could slightly improve foraging conditions for salmon and bull trout. The public use program under this alternative is not expected to affect chinook salmon or bull trout.

4.3.5.2 Action Alternatives B - D

Estuarine restoration under Alternatives B, C, or D would increase the amount (458, 515, and 699 acres, respectively) and improve the quality of essential habitats of chinook salmon and bull trout. No long-term adverse effects to chinook salmon compared to baseline conditions would be anticipated under the action alternatives. There may be temporary negative effects from reduced water quality caused by increased turbidity due to dike removal and channel modifications.

Little is known about the current status of the bull trout in the Nisqually River system (WDFW 1997). Anadromous bull trout, if present, would benefit most under Alternative D, followed by Alternatives C, and B, respectively. Restoration of the estuary is expected to result in increased primary production and consequent food chain support for nearly all fish species which depend upon estuarine and shallow marine habitats for survival, including prey fish species preferred by bull trout. An increase in forage fish abundance in the Nisqually Estuary due to estuarine restoration would likely benefit bull trout. Based upon these studies of bull trout in north Puget Sound, restoration of the Nisqually River estuary, particularly under Alternatives D and C, would substantially increase available foraging and rearing habitat for juvenile, sub-adult, and adult bull trout.

4.4 Effects to Wildlife

Under all alternatives, resource monitoring programs would be implemented. Refuge wildlife monitoring is a priority for the NWRS and would support adaptive management techniques that could be utilized for the benefit of various wildlife species (USFWS 2000). Potential effects are described below for birds, mammals, reptiles and amphibians, invasive and exotic species, and threatened and endangered species.

4.4.1 Effects to Birds

4.4.1.1 Alternative A

Habitat Restoration

Effects to Waterfowl, Waterbirds, Seabirds, and Shorebirds

A number of waterfowl, waterbird, seabird, and shorebird species use the freshwater wetlands within the diked area on the Refuge, particularly the seasonally flooded ponds. Waterfowl, such as American wigeon, Canada geese, mallards, and northern shovelers, make extensive use of specific types of freshwater wetlands and would benefit from the continued existence of this habitat within the Refuge boundary. Waterbirds that use permanent ponds or sloughs, such as great blue herons, American bitterns, and Virginia rails, would also benefit from the continued management of these areas. In addition, dunlin, common snipe, and killdeer use flooded wetlands and grasslands within the diked area. Shorebirds, such as common snipe and killdeer have both been documented to be declining in Washington State and across the region (Sauer et al. 2000) and would benefit from the continued management of freshwater wetlands and grasslands.

The management of current grassland habitat would continue to benefit Canada geese, particularly migrant populations. Geese currently concentrate in Refuge grasslands and would continue to do so under this alternative. Migratory populations are not considered to be increasing in Washington, unlike the resident population (United States Department of Agriculture [USDA] 1999). It is uncertain if Canada geese resident populations would increase under this alternative, but increases would be likely based on regional trends. Supporting large resident Canada geese populations can have detrimental effects on other Refuge flora and fauna (Smith et al. 1999). However, current resident populations are low and are not affecting habitat conditions.

Benefits to waterfowl, waterbirds, and shorebirds would gradually continue to decline because of the increased challenge of maintaining the quality of the freshwater wetlands and grasslands within the diked area. Habitat quality within the dike is declining as reed canary grass dominance continues, modifying the vegetation community and closing in open water areas (see Section 4.2.1). Although limited reed canary grass control would be implemented, its expansion would be expected to increase and would decrease seasonally flooded wetlands in the long term.

The continued conversion of grasslands to scrub-shrub habitat would also decrease the availability of seasonal wetland habitat used by waterfowl, herons, and shorebirds.

In addition, the current dike system is not stable and is expected to deteriorate over time. Repair work may increase short-term sedimentation and thus negatively affect waterfowl and waterbirds. Long-term examination of the diked system indicates that it would not naturally maintain itself, contributing to saltwater intrusion, which would decrease habitat value for all areas (see Section 4.2.1).

Although freshwater wetlands on the Refuge provide habitat for some ducks and geese, Refuge monitoring data suggest that the majority of waterfowl use estuary areas (see Section 3.4.1). In addition, other species, such as herons, dunlins, western sandpiper, loons, gulls, and terns, concentrate in the estuary areas. The persistence of the current dike system may still affect the existing estuary due to tidal mudflat erosion, artificial sediment accretion patterns, and reduced tidal prism (see Section 4.2.1). Populations of American wigeon and other waterfowl on the Refuge have been declining in recent years. A possible cause for this decline is the change in habitat types in the region. Additional loss or deterioration of estuarine habitats in Puget Sound would continue to adversely affect many waterfowl species (Quiñonez 2001).

There is international concern regarding the long-term sustainability of shorebird species (Brown et al. 2000). Western sandpipers are considered a priority species in Washington due to their levels of concentration in certain areas (WDFW 2001). Estuaries are critical habitat because they typically support a great abundance and diversity of shorebirds compared to other habitats in the North Pacific region (Drut and Buchanan 2000). Threats to estuary-dependent species would continue under Alternative A due to maintenance of the current dike system, which would further degrade the existing estuary (Section 4.2.1). This alternative does not address estuarine restoration priorities identified in the Pacific Coast Joint Venture Strategic Plan (Pacific Coast Joint Venture 1996) and the Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000). Overall, as discussed in Section 4.2.1, the estuarine habitats in the delta would not benefit from actions proposed in this alternative. The limited health and function of the salt marshes and sloughs of the delta would result in a less productive, less complex, lower channel order system that provides less habitat for waterfowl, waterbirds, seabirds, and shorebirds.

Effects to Landbirds

Raptors

Red-tailed hawks, barn owls, and northern harriers would benefit the most of all raptors from retaining the diked freshwater wetlands and grasslands. However, as described in Section 4.2.1, habitat quality within the dike is declining. The continued conversion from open wetlands and grasslands to scrub-shrub or reed canary grass dominated habitat would limit raptor use of the diked areas in the long term. Populations of other raptor species that forage in estuary areas, such as eagles, peregrine falcons, and osprey, could be negatively affected in the long-term, although not significantly, from the continued deterioration of estuarine habitat under this alternative (see Section 4.2.1).

The restoration of the West Bluff parcel, as called for under all alternatives, would enhance raptor habitat and have positive effects. Bald eagles that nest in this area would benefit from enhanced forest quality around the nest site. Washington State species guidelines indicate that eagles benefit from contiguous forested habitat with low human disturbance (Rodrick and Milner 1991). In addition to eagle habitat improvements, other raptor species, such as red-tailed hawks or owls, would benefit as most of these species nest or perch in trees along the West Bluff parcel.

Passerines and Nonpasserines

The restoration of the West Bluff parcel, common to all alternatives, would benefit passerine and nonpasserine species. Notable species that could benefit from enhanced forest habitat include downy woodpecker, Swainson's thrush, band-tailed pigeon, rufous hummingbird, olive-sided flycatcher, and yellow warbler. All of these species are declining in Washington State (Sauer et al. 2000).

Species that use the estuary, such as swallows, marsh wren, and finches, could be negatively affected by the continued deterioration of the estuarine habitat (Section 4.2.1). The retention of 1,000 acres of freshwater wetland and grassland habitat under Alternative A would continue to benefit certain passerines, such as savanna sparrows and goldfinches, that are associated most with this habitat type. However, the limited freshwater habitat enhancements under this alternative are not expected to significantly improve habitat quality over the long term. Freshwater wetlands within the current Refuge boundary are expected to deteriorate over time as a result of ongoing exotic species invasion and conversion to scrub-shrub habitat (Section 4.2.1). Thus, benefits from the availability of freshwater wetlands to passerines and nonpasserines are not expected to increase significantly, but instead could eventually decrease due to deteriorated habitat conditions.

Refuge Expansion

Effects to Waterfowl, Waterbirds, Seabirds, Shorebirds, and Landbirds

Under Alternative A, no expansion of the Refuge boundary would occur. Indirect benefits to waterfowl, waterbirds, seabirds, shorebirds, and landbirds would occur if efforts to strengthen watershed protection through partnerships outside of the Refuge boundary were successful. Increased watershed protection would improve water quality and associated habitat for the various avian species.

Efforts to acquire in-holdings within the existing boundary would continue under all alternatives. Acquisition of in-holdings consisting of estuarine habitat would eliminate the fragmented management of estuarine areas within the delta. Coastal wetlands are critical to shorebird migration as foraging sites (Page and Gill 1994). The documented widespread decline in estuarine habitat threatens shorebird population viability throughout the region (Drut and Buchanan 2000). Acquisition and long-term protection of these areas would benefit waterfowl, waterbird, seabird, and shorebird species.

Public Use Program

Effects to Waterfowl, Waterbirds, Seabirds, Shorebirds, and Landbirds

Under Alternative A, the recreational trail system would not change and would continue to be used for hiking and wildlife observation. Although this activity could have negative effects on avian species, especially those using habitats adjacent to trails, effects would be reduced through provisions described below. Studies have shown that migrant waterfowl are particularly vulnerable to disturbances from trail-based recreation (Klein et al. 1995). Many waterbird species were found to decrease their foraging time and increase their vigilance when people were nearby (Burger and Gochfeld 1998). Birds can be affected by human activities on trails when they are repeatedly disturbed and flushed from feeding, resting, or nesting areas. Shorebird numbers were reduced near people who were walking or jogging and about 50% of flushed birds flew elsewhere (Burger 1981). Flushing from an area can cause birds to expend more energy, be deterred from using desirable habitat, affect resting or feeding patterns, increase exposure to predation, or cause birds to abandon sites with repeated disturbance (Smith and Hunt 1995). Recreational effects can have long-term cumulative effects that cause avian species to abandon otherwise suitable habitat (Riffell et al. 1996). However, since the number of trail users would be limited by the Refuge parking lot capacity (100-car maximum), the number of Refuge visitors on the trail system at one time is not expected to be exceptionally high. In addition, the requirement to stay on trails and designated sanctuary areas would greatly lessen human disturbance. Vegetative screening (plantings) would also reduce disturbance and increase wildlife viewing opportunities. Refuge outreach programs would emphasize responsible behavior of Refuge visitors and thus lessen wildlife disturbance (DeLong and Schmidt 1998; Larson 1995).

Under all alternatives, the restriction of fruit harvesting would benefit many passerines and nonpasserines that use these resources for forage, as well as reduce the potential for visitors to wander off trails for fruit picking. The primitive trail in the surge plain (common to all alternatives) could have negative effects on passerines and nonpasserines that occur in this habitat, especially if visitors wander off trail into the habitat. For many passerine species, primary song occurrence and consistency can be affected by a single visitor (Gutzwiller et al. 1994). This could potentially limit the number of breeding pairs of certain passerine species, thus limiting production (Reijnen and Foppen 1994). However, measures described above would lessen disturbance.

The environmental education program under Alternative A would be limited, serving up to 5,000 students each year. Since activities associated with this program would be focused on trails or within the Environmental Education Center, no significant effects to avian species are expected. Design of existing and new trails and facilities would provide adequate sanctuary for avian populations. A reservation system would be used to enforce a daily limit (100 students) for educational groups. A reduction in human disturbance along the west shoreline of McAllister Creek would benefit bald eagles and osprey, which frequent the area for foraging. Improved protection measures there would occur under all alternatives and would positively affect raptors.

Under this alternative, hunting would occur as it does currently on WDFW lands and much of the Refuge tideflats. The continued presence and associated activity of hunters across a wide area could have negative consequences to waterfowl, which are sensitive to disturbance. The amount of waterfowl harvest is not expected to have a measurable effect on Refuge populations, especially since waterfowl hunting activity is not extremely high in the delta. For example, the average hunter visits per day was 8.4 during the 1998/99 season (USFWS unpublished data). Direct effects of hunting on waterfowl are mortality, wounding, and disturbance (DeLong 2002). Hunting can alter behavior (foraging time), population structure, and distribution patterns of wildlife (Owens 1977, Raveling 1979, White-Robinson 1982, Thomas 1983, Bartelt 1987, Madsen 1985, and Cole and Knight 1990). In Denmark, hunting was documented to affect the diversity and number of birds using a site (Madsen 1995). Avian diversity changed from predominantly mute swan and mallard to a more even distribution of a greater number of species when a sanctuary was established. Hence, species diversity increased with the elimination of hunting.

There also appears to be an inverse relationship between the numbers of birds using an area and hunting intensity (DeLong 2002). In Connecticut, lesser scaup were observed to forage less in areas that were heavily hunted (Cronan 1957). In California, the numbers of northern pintails on Sacramento NWR non-hunt areas increased after the first week of hunting and remained high until the season was over in early January (Heitmeyer and Raveling 1988). Following the close of hunting season, ducks generally increased their use of the hunt area; however, use was lower than before the hunting season began.

Human disturbance to wintering birds and other wildlife using the open waters and marshes on the Nisqually delta would occur as a result of hunting activity. Migratory and wintering waterfowl generally attempt to minimize time spent in flight and maximize foraging time because flight requires considerably more energy than any other activity, other than egg laying. Human disturbance associated with hunting includes loud noises and rapid movements, such as those produced by shotguns and boats powered by outboard motors. This disturbance, especially when repeated over a period of time, compels waterfowl to change food habits, feed only at night, lose weight, or desert the feeding area (Belanger and Bedard 1995, Madsen 1995, Wolder 1993). Disturbance levels from hunting activity outside Chincoteague NWR were found to be high enough to force wintering black ducks into a pattern of nocturnal feeding within surrounding salt marsh and diurnal resting within Refuge impoundments (Morton et al. 1989a, 1989b). Unhunted populations have been documented to behave differently from hunted ones (Wood 1993).

These impacts can be reduced by the presence of adjacent sanctuary areas where hunting does not occur, and birds can feed and rest relatively undisturbed. Sanctuaries or non-hunt areas have been identified as the most common solution to disturbance problems caused from hunting (Havera et. al 1992). Prolonged and extensive disturbances may cause large numbers of waterfowl to leave disturbed areas and migrate elsewhere (Madsen 1995, Paulus 1984). In Denmark, hunting disturbance effects were experimentally tested by establishing two sanctuaries (Madsen 1995). Over a 5-year period, these sanctuaries became two of the most important staging areas for coastal waterfowl. Numbers of dabbling ducks and geese increased 4 to 20 fold

within the sanctuary, and these species prolonged their staging periods up to several months compared to baseline periods (Madsen 1995). Thus, sanctuary areas are very important to minimize disturbance to waterfowl populations to ensure their continued use of the Nisqually delta.

Boating activity associated with hunting during the fall and winter can alter distribution, reduce use of particular habitats or entire areas by waterfowl and other birds, alter feeding behavior and nutritional status, and cause premature departure from areas (Knight and Cole 1995). In the upper Midwest, motor boating and hunting have been found to be the two main activities that disturb waterfowl (Korschgen et al. 1985). In Connecticut, selection of feeding sites by lesser scaup was influenced by disturbances such as hunters, anglers, and pleasure boaters (Cronan 1957).

Recreational boating, estimated at 6,700 boats per year on the Refuge, can directly affect distribution and habitat use by migratory birds. More sensitive species may find it difficult to secure adequate food or loafing sites as their preferred habitat becomes fragmented and recreation-related disturbances increase (Skagen et al. 1991; Pfister et al. 1992). Motorized boats are likely to have more impact on wildlife than non-motorized boats because motorboats produce a combination of movement and noise (Tuite et al. 1983; Knight and Cole 1995). For example, a significant decrease in the proportion of bald eagles feeding at a site was observed when motorized boating activity occurred within 200 meters of that area in the preceding 30 minutes (Skagen 1980). Motorized boats can also cover a larger area in a relatively short time, in comparison to non-motorized boats. Boating pressure on wintering waterfowl in Germany had reached such a high level that it was necessary to establish larger sanctuaries and implement a seasonal closure on water sports and angling (Bauer et al. 1992).

Even canoes and kayaks can cause significant disturbance effects based on their ability to penetrate into shallower areas of the marsh (Speight 1973; Knight and Cole 1995). In the Ozark National Scenic Riverway, green-backed heron activity declined on survey routes when canoes and boat use increased on the main river channel (Kaiser and Fritzell 1984). Canoes or slow-moving boats have also been observed to disturb nesting great blue herons (Vos et al. 1985). Huffman (1999) found that non-motorized boats within 30 meters of the shoreline in south San Diego Bay caused all wintering waterfowl to flush between the craft and shore. However, compared to motorboats, canoes and kayaks appear to have less disturbance effects on most wildlife species (Jahn and Hunt 1964; Huffman 1999; DeLong 2002).

The presence of fast-moving boats also caused the most significant modifications to the amount of time animals spent feeding and resting. In England, an increased rate of disturbance from boats partly caused a decline in roosting numbers of shorebird species (Burton et al. 1996). In addition, boaters have been observed to cause massive flights of diving ducks on the Mississippi River (Thornburg 1973). Motorized boats within 100 meters of shore caused all wintering waterfowl and shorebirds to flush between the craft and shore in south San Diego Bay, regardless of speed (Huffman 1999). However, disturbance to birds in general was reduced when boats traveled at 5 mph speed limits.

Impacts of boating can occur even at low densities, given their noise, speed, and ability to cover extensive areas in a short amount of time. The total number of boats and people can be an inappropriate measure of recreational intensity because the presence of a single boat might be just as disturbing as that of many (Tuite et al. 1983; Knight and Knight 1984). This is especially the case in the RNA and McAllister Creek, both areas with high waterfowl use. Service survey data show that the RNA provides important resting and feeding habitat for large numbers of wintering waterfowl, including many wigeon, the predominant waterfowl species on the Refuge. Typically, the largest waterfowl concentrations are found in the RNA during the winter months.

The habitat along McAllister Creek is a relatively narrow tidal system that receives high use by a variety of waterfowl, waterbirds, wading birds, and raptors. Because boats in confined areas are generally closer to shorelines, waterbirds in tidal creeks and rivers may be exposed to more human activity than birds at other shoreline habitats (Bratton 1990). Even low levels of boating activity affect the duration and pattern of use by wildlife in this narrow system.

Boating activity also disturbs nesting birds. In Denmark, fast-moving boats were observed to have the greatest impact on red-breasted merganser broods (Kahlert 1994). An active bald eagle nest is located along McAllister Creek. The nesting period identified in the Bald Eagle Recovery Plan identifies January 1 as the beginning of the nesting season when special protective measures should begin (USFWS 1986). A great blue heron nesting colony, located along McAllister Creek since the 1970s, has been declining for several years. Nesting great blue herons are sensitive to a variety of human disturbances. Great blue herons were one of the more sensitive of 23 waterbird species, when measuring flush distances from motorized boats and PWC (Rodgers and Schwikert 2002). Washington State requires a minimum 300-meter buffer zone to protect colonies from human disturbances (WDFW 2001). However, boating activity in McAllister Creek falls within this buffer zone. It is possible that boating activities may be one of the contributing factors affecting these nesting birds.

PWC have more impact on wildlife than other motorized or non-motorized boats because they operate at high speeds and can maneuver into shallow areas (6 inches deep), penetrating areas not available to conventional boats (Izaak Walton League of America 1999). PWC have the capability to operate on top of salt marshes or mudflats with little or no standing water, causing direct damage to soils and habitat. The rapid overwater movement and loud noise created by PWC have been found to be the most disturbing type of boating activities for wildlife (Dalgren and Korschgen 1992). PWC produce noise levels in the range of 85 to 105 decibels (dB) per unit according to data produced by the National Park and Conservation Association (1997). The continual change in loudness and pitch during normal use make PWC more disturbing than the constant sounds of conventional motorized boats. PWC have been observed flushing wading birds and nesting ospreys in Florida (Snow 1989). PWC use also affected nesting success of common terns at Barnegat Bay, New Jersey, with larger numbers flushing in response to PWC than motorboats (Burger 1998). Rodgers and Schwikert (2002) found that great blue herons exhibited a greater flush distance from PWC compared to motorized boats.

Motorized boats introduce pollution, in the form of gas and oil in water, and particulates in the air in estuarine and riverine habitats at the Refuge. Two-stroke engines may lose about 25 to 40% of the unburned fuel and oil mix directly into the water (Muratori 1968). An EPA report

indicates that two-stroke engines found on many motorized boats and typical of PWC discharge as much as 25% of unspent oil and gas directly into the water. Hydrocarbons in gas and oil released from two-stroke engines float on the surface and settle within shallow estuarine habitats. Hydrocarbon pollution has been found to bioaccumulate within the complex food web, posing a serious threat to the marine environment (Tjarnlund et al. 1993). Hydrocarbons can also be transferred to eggs from the plumage of incubating birds. Extremely small amounts of petroleum hydrocarbons can be toxic to eggs and birds that may ingest it (Hoffman 1989). PWC emit significantly more pollution than two-stroke outboards due to differences in horsepower, payload, and operation (California Air Resources Board 1998). The EPA has adopted regulations (40 CFR Part 91) that require marine engine manufacturers to improve the efficiency of engines by 2006. The EPA expects a 50% reduction in hydrocarbon emissions from present levels in marine engines by 2020.

Prolonged and extensive disturbances may cause large numbers of waterfowl to leave disturbed areas and migrate elsewhere (Madsen 1995; Paulus 1984). In Denmark, disturbance effects were experimentally tested by establishing two sanctuaries (Madsen 1995). Over a 5-year period, these sanctuaries became two of the most important staging areas for coastal waterfowl. Numbers of dabbling ducks and geese increased 4 to 20 fold within the sanctuary, and these species prolonged their staging periods up to several months compared to baseline periods. Thus, protection from disturbance is very important to waterfowl to ensure their continued use of the Nisqually delta.

Motorized boats and PWC use also result in conflicts with individuals participating in wildlife-dependent priority public uses, such as canoers, kayakers, wildlife observers, and anglers. Rapid movement and loud noise, particularly associated with PWC, flush wildlife, taking away wildlife observation opportunities. Loud noise and rapid, repeated movement disrupt the experience of visitors participating in priority public uses, including viewing wildlife. Dungeness NWR and San Juan County in northwest Washington have eliminated PWC use to reduce wildlife disturbance and conflicts with other users, and Thurston County has recently strengthened localized regulations.

4.4.1.2 Alternative B

Habitat Restoration

Effects to Waterfowl, Waterbirds, Seabirds, and Shorebirds

Under Alternative B, 318 acres of diked habitat would be restored to a muted estuarine system, and 140 acres would be restored to a fully functioning estuarine system. Alternative B is the only action alternative that would create muted estuarine habitat, which affects its function and predictability of success.

Waterfowl, waterbird, seabird, and shorebird species that use the estuary would most likely benefit from restoration actions. The magnitude of benefit would depend on the extent to which these species use the muted estuarine area. Dabbling ducks, such as American wigeon, have been observed to use temporary muted estuary areas that resulted from past dike breaching

events at the Refuge (Klotz et al. 1978). However, predicted waterfowl use in muted estuarine areas is uncertain because long-term habitat response may not be equivalent to short-term events. The ability of muted estuarine habitats to mimic the structure and function of full estuarine habitat is not well known (Section 4.2.2). The extent of the benefits depends on the dynamics of the tidal interchange that would result from the restoration. Consequently, the benefit to waterfowl, waterbirds, seabirds, and shorebirds is uncertain. Species that primarily use estuarine habitat, such as American wigeon, green-winged teal, and bufflehead, are expected to benefit from the creation of the muted estuary. Herons are also likely to use the muted estuarine area since they currently utilize all the habitats of the Refuge and are known to be generalist feeders (see Section 3.4.2). Dunlin and other shorebird species are also expected to use the newly established mudflats that would serve as feeding areas. In addition, roosting and feeding areas may be available at different times due to delayed tidal flows, which could benefit shorebirds when adjacent tidal areas are inundated. The extent of the benefits expected under this alternative depends on the dynamics of the tidal interchange that would result from the restoration.

There is more certainty that the fully restored estuarine area would benefit these same estuary-dependent species. In addition, loons, gulls, mergansers, and other water-associated birds that use estuarine habitat would benefit from a larger estuary area in the delta. However, use of both muted and full estuarine areas by these species may not be immediate. The newly breached areas would experience a short-term loss of vegetation as plants not adapted to saltwater die and are gradually replaced by saline-tolerant species (Harris and Marshall 1963). This would then be followed by a period of transition, when intertidal and salt marsh plants and invertebrates colonize. This process could temporarily decrease prey for avian species.

Alternative B addresses the estuarine restoration priority for shorebird and waterfowl management identified in the Pacific Coast Joint Venture Strategic Plan (Pacific Coast Joint Venture 1996) and the Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000). Alternative B would provide more estuarine habitat than Alternative A. However, the benefits from estuarine restoration under Alternative B would not be as great as those under Alternatives C or D because the area provided is smaller and includes a high proportion of muted estuarine habitat.

Some avian species would be negatively affected by the conversion of freshwater habitat to estuarine habitat. Species such as American bittern, sora, Virginia rail, and green heron would lose some freshwater habitat. The conversion of the north Shannon Slough system to a full estuarine area would temporarily negatively affect several waterfowl species that currently use the area. Since many of these waterfowl species also use the estuary, they would not be significantly affected by this loss. In addition, loss of freshwater habitat would also temporarily affect some shorebird species, such as breeding snipe and killdeer. The estuarine restoration areas are currently not the primary areas on the Refuge in which these species occur; therefore, the effects would not be significant. In addition, the improvements in freshwater habitat management on the remaining diked area are expected to increase habitat quality for these freshwater-dependent species, including high tide roosting sites for shorebirds. The wood duck is another freshwater-dependent species that would lose nesting and foraging habitat around the ring dike area. However, the remainder of the riparian corridor along the Nisqually River is

expected to remain, and riparian restoration within the dike would enhance available habitat for this species.

As described in Alternative A, the persistence of the current dike system may still affect the existing estuary due to tidal mudflat erosion, artificial sediment accretion patterns, and reduced tidal prism (see Section 4.2.1). The limited health and function of the salt marshes and sloughs of the delta would result in a less productive, less complex channel system that provides less habitat for waterfowl, waterbirds, seabirds, and shorebirds.

Freshwater habitat improvements proposed in Alternative B would benefit many waterfowl, waterbird, and shorebird species and would reduce the effects from the conversion of freshwater habitat to estuarine habitat. Freshwater wetland habitats are limited in the Puget Sound region (Tanner 1999), especially areas without reed canary grass. Improvements in these freshwater habitats on the Refuge would benefit regional waterfowl populations (Hoffman and Kearns 1997). Alternative B offers the largest freshwater wetland area compared to Alternatives C and D, although the large diked area in Alternative B would limit water management capabilities and the control of reed canary grass, resulting in limited improvements in freshwater habitat quality (see Section 4.2.2). However, species such as wood duck, killdeer, rails, and soras, which primarily use the freshwater habitats, would benefit to some degree from improved freshwater habitat.

The maintenance and creation of dike systems and other project implementation actions may lead to short-term increases in sedimentation in a few wetland areas. This could negatively affect waterfowl and waterbirds that use these areas through a short-term decline in prey availability (Waters 1995).

Effects to Landbirds

Raptors

The creation of additional estuarine habitat under this alternative would increase winter waterfowl numbers benefitting some raptor species, such as eagles, osprey, falcons, and northern harriers that feed regularly in the estuary. However, since Alternative B has the least amount of estuarine restoration compared to Alternatives C and D, it would least benefit raptor species using the estuary. The extent of benefit to these species would also depend on the response of prey populations in the muted estuarine area; as described above, there is uncertainty whether the muted estuarine area would successfully mimic the structure and function of fully functional estuarine habitat, and the effect on raptor species is more difficult to predict.

The estuarine habitat created under Alternative B would be configured with more patchiness and edges than under Alternative C or D. This could benefit red-tailed hawks, sharp-shinned hawks, and other raptors that forage successfully along edges. However, this edge effect can have negative long-term effects on all raptor species as fragmented prey populations may not sustain themselves as well as those in more continuous areas (Meffe and Carroll 1994). Larger and more contiguous habitat would be more beneficial in terms of species viability; thus, this alternative would have fewer benefits relative to Alternatives C and D (Morrison et al. 1992; Noss et al. 1997).

Freshwater and grassland habitat improvements in Alternative B would benefit raptor species that use these areas, especially those that feed more predominantly on small mammals. Owls, red-tailed hawks, and northern harriers would all benefit, although not significantly. Benefits to these species would be limited because of minimal freshwater and grassland management (see Section 4.2.2). In addition, these species, especially northern harriers and great-horned owls, forage in estuarine habitats as well.

Common to Alternatives B, C, and D are short-term vegetation die-backs associated with the shift from fresh to saltwater systems. As described above, the expected short-term effects to prey species would also negatively affect raptor species. Negative effects to prey species associated with the maintenance of dike structures would also affect raptor species.

Passerines and Nonpasserines

The restoration of estuarine habitat would benefit some passerine and nonpasserine species. Species that regularly use this habitat include swallows, kingfishers, common yellowthroats, song sparrows, and red-winged blackbirds. As described above, Alternative B would provide the least benefit to passerine and nonpasserine species that use the estuary, as compared to Alternatives C and D. European starlings may have an advantage under Alternative B due to the increase in edges and fragmentation of the estuarine habitat. It is likely that starlings would persist on the Refuge under all alternatives due to the proximity of the Refuge to human development and thus would continue to compete with native birds for feeding and nesting habitat.

The conversion of freshwater to estuarine habitat would negatively affect some passerine and nonpasserine species that primarily use freshwater and grassland habitats. These include purple and house finches, northern flickers, western meadowlarks, hummingbirds, and savanna sparrows. However, improvement in freshwater habitat management would increase the quality of the remaining diked area. Currently, freshwater wetlands are degraded because of the dominance of reed canary grass. Restoration of these areas, especially in terms of exotic species and water level control, would increase carrying capacities of most passerines to be equal or in excess of those areas lost. However, species predominantly found in grasslands (e.g., meadowlarks and savanna sparrows) would be most negatively affected as the proportion of freshwater wetlands would be increased in proportion to grasslands. In addition, the small amount of riparian restoration in this alternative is also expected to improve riparian habitat for passerine and nonpasserine species. Riparian restoration is identified as a conservation management priority in this region in the Conservation of Land Birds Plan (Pashley et al. 2000). The increase in freshwater wetland and riparian habitat quality may reduce the effects of conservation due to estuary restoration. However, benefits to these species would be limited by limited management capabilities in this area (see Section 4.2.2).

Refuge Expansion

Effects to Waterfowl, Waterbirds, Seabirds, Shorebirds, and Landbirds

In addition to effects described in Alternative A, Alternative B proposes 2,407 acres of Refuge expansion. This addition would protect additional forested lands along the East Bluff and floodplain habitat south of I-5. Proposed expansion efforts in Alternatives B, C, and D would

incorporate new freshwater wetland areas into the Refuge. This would provide increased freshwater wetland acreage and some grasslands that could reduce the effects from the conversion of freshwater wetland and grasslands to estuarine habitat. However, because expansion could occur over many years, this reduction may not occur simultaneously with estuarine restoration.

Acquisition or management of floodplain, freshwater wetland, and grassland areas south of I-5 in the lower Nisqually Valley would provide long-term protection of these areas, as well as restoration opportunities. Seasonal wetland restoration projects on former agricultural lands would be very similar to those conducted on current Refuge lands within the diked area. For example, seasonal wetlands west of the headquarters area were enhanced in 2001 by mowing dense reed canary grass areas, discing, sculpting new depressions and seasonal ponds, and seeding, followed by flooding during the fall and winter months; these projects greatly enhanced waterfowl habitat. This would benefit many species of waterfowl and shorebirds that travel between the Refuge and seasonally flooded wetlands south of I-5. As described above, since Refuge expansion may not occur immediately, benefits to these species may not occur in the short-term. Improvements to freshwater areas under this alternative could benefit species such as killdeer, common snipe, and wintering flocks of dunlin, geese, wigeon, and other dabbling ducks. Many species of waterbirds and landbirds would also benefit from long-term protection of riparian and freshwater wetland areas. These include species such as belted kingfisher, yellow warbler, willow flycatcher, downy woodpecker, and Swainson's thrush. Proposed expansion would also have positive effects on raptors, especially northern harriers, red-tailed hawks, owl species, and kestrels that would use the areas south of I-5 for foraging and possibly nesting. Grassland species, including raptors, savanna sparrows, western meadowlarks, and goldfinches, would also benefit. However, the proposed expansion area in Alternatives B and C is not as large as in Alternative D.

Expanding protection to the East Bluff would better protect water quality of the adjacent estuarine habitats, as described under Section 4.2.2, and thus improve habitat quality for waterfowl, waterbirds, seabirds, and shorebirds in the estuarine habitat. The expansion on the East Bluff may increase protected habitat for all raptor species, especially small hawk species that prefer forested habitat. The proposed expansion would also reduce habitat fragmentation that currently occurs within the expansion area, improving connectivity and wildlife movement within and between areas. Overall, reduction in habitat fragmentation would increase undisturbed foraging, resting, and shelter areas available for wildlife. The benefit from decreased fragmentation under this alternative would be larger than under Alternative A but smaller than Alternative D (and the same as Alternative C).

Public Use Program

Effects to Waterfowl, Waterbirds, Seabirds, Shorebirds, and Landbirds

Under all action alternatives, the Luhr Beach area would be cooperatively managed with WDFW. Since this is a major access point for boaters, especially hunters and anglers, the installation of a Visitor Contact Station would increase visitor awareness and thus decrease disturbances from these recreational activities to waterfowl, shorebirds, and other species using the delta.

Effects to various bird species from activities associated with the recreational trail system would be similar to those described in Alternative A, especially since the trail system in Alternative B is only slightly different than in Alternative A. Eagles nesting along the West Bluff may experience less disruption under the Alternative B trail plan because the loop trail would be routed away from the McAllister Creek corridor. However, under Alternative B, the newly created full estuarine area would be encircled on three sides by a recreation trail. High public access of this area could have negative effects on waterfowl, waterbirds, and shorebirds. In addition, the EE program would be increased to serve up to 20,000 students, the largest proposed program of all the action alternatives. Disturbances to wildlife using habitats adjacent to the trail system from education groups would be the highest of all the alternatives. However, these effects would be minimized because groups would be restricted to trails and study sites and restricted to a 100 student/day limit. New trails and study sites would be located where minimal effects to Refuge resources would occur; as described above, Refuge outreach programs would emphasize responsible behavior and thus would lessen wildlife disturbance effects.

Waterfowl hunting would be limited to WDFW lands. The discontinuation of unauthorized hunting on Refuge lands would benefit wintering waterfowl that use Refuge habitats, as well as shorebirds and waterbirds also disturbed by the activity. However, the unconsolidated WDFW lands would fragment hunting-free areas and affect use patterns in and adjacent to Refuge lands by waterfowl, waterbirds, and shorebirds. Under all action alternatives, the RNA would be posted, and a no-hunting policy would be enforced. This would be an improvement over Alternative A, as wildlife disturbances would decrease for waterfowl, waterbirds, seabirds, and shorebirds. Additionally, the closure of shellfishing and other consumptive uses in the RNA would further protect shellfish populations, which may improve shorebird prey availability. Decreased disturbance to all these species in the estuary could also benefit various raptor species such as bald eagles, peregrine falcons, and osprey. The restriction of public access into the restored estuarine habitat under Alternatives B, C, and D would benefit all of the species described above.

Boating restrictions under all action alternatives are expected to have positive effects on waterfowl, waterbird, seabird, and shorebird species that use the estuary, Nisqually River, and McAllister Creek. Winter boating closures in the RNA would provide sanctuary for many migratory waterfowl, shorebirds, waterbirds, and raptors during a critical period. The new boating regulations (5 mph speed limit) would largely preclude the operation of PWC in Refuge waters. Boat restrictions under all action alternatives would improve estuarine habitat and decrease wildlife disturbance.

4.4.1.3 Alternative C

Habitat Restoration

Effects to Waterfowl, Waterbirds, Seabirds, and Shorebirds

Waterfowl, waterbird, seabird, and shorebird species that use the estuary would benefit from the restoration actions under Alternative C, similar to that described under Alternative B. However, since the restoration of full tidal conditions in the intertidal and river delta habitats would be in a larger area, benefits to waterfowl, particularly dabbling species (such as American wigeon and

green-winged teal), waterbirds, seabirds, and shorebirds would be greater compared to Alternative B. The enhanced tidal and sediment flow through the Nisqually River would likely improve estuarine habitat quality. Alternative C (and D) would restore a continuous estuary area, eliminating the uncertainties associated with the muted estuarine habitat provided in Alternative B. Waterfowl populations would likely increase due to the documented higher use in estuarine habitats on the Refuge (Shanewise 1996; USFWS data). Loons, grebes, terns, gulls, and herons that forage in estuarine areas would also benefit from the increased acreage of estuarine habitat. Dunlin and other shorebird species would also use the newly established mudflats as feeding areas. Since the estuarine habitat restoration actions accomplished under this alternative are more sustainable and would function more naturally in terms of tidal flow and sediment accretion than under Alternative B, restoration actions would provide higher quality estuarine habitat.

As in Alternative B, newly breached areas would experience a short-term loss of vegetation as plants not adapted to saltwater die and are gradually replaced by saline-tolerant species (Harris and Marshall 1963). Alternative C addresses the estuarine restoration priority for shorebird and waterfowl management identified in the Pacific Coast Joint Venture Strategic Plan (Pacific Coast Joint Venture 1996) and the Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000).

Issues related to freshwater wetlands under Alternative C would be similar to those in Alternative B. Some species, such as American bittern, sora, Virginia rail, green heron, and wood duck, would be negatively affected from the conversion of 515 acres of freshwater habitat to estuarine habitat. However, implementation of intensive habitat improvement measures would be more feasible and effective because of the smaller acreage (447 acres versus 542 acres), resulting in higher quality freshwater wetlands than in Alternatives A and B. Less edge and greater habitat connectivity could also lead to higher quality freshwater habitat than under Alternative B. Higher habitat quality would increase the number of waterfowl, waterbirds, and shorebirds that the Refuge could support in the remaining freshwater habitat. In addition, the retention of the north Shannon Slough system would benefit many waterfowl (e.g., wigeon, bufflehead, and pintail) and waterbird species (e.g., great blue heron, bittern, and Virginia rail) that currently use the area.

As described in Alternative B, the maintenance and creation of dike systems and other project implementation actions may contribute to short-term sedimentation as well as affect the health and function of the estuary (Section 4.4.1.2).

Effects to Landbirds

Raptors

The improvements in estuarine habitat under Alternative C would benefit raptor species that use this habitat. Alternative C would have a larger estuary area (515 acres) than Alternatives A and B and would thus improve raptor habitat more than Alternatives A and B for such species as eagles, falcons, osprey, and northern harriers that feed regularly in the estuary.

As described in Alternative B, the loss of open grassland areas would affect species, such as the red-tailed hawk, that feed predominantly on small mammals and depend heavily on this habitat. The reduction of grasslands would likely reduce small mammal populations on parts of the Refuge and thus would reduce foraging areas for some species. However, improved management of grassland areas interspersed among the remaining freshwater wetland areas would provide higher quality grasslands than the existing reed canary grass dominated areas. The intensified reed canary grass control under Alternative C would promote prey species abundance, and the remaining habitat would provide higher quality foraging habitat for some raptors. The positive effects of freshwater management under this alternative for shorebirds and waterfowl would also increase prey potential for falcons and eagles.

Riparian zones would benefit under this alternative. The restoration of riparian habitat north of the Twin Barns, as provided under Alternative C (and D), would provide additional foraging, perching, and nesting sites for raptor species.

Passerines and Nonpasserines

Estuary restoration under Alternative C would be larger than in Alternative B and, thus, would have similar but somewhat greater effects for passerine and nonpasserine species. Species that regularly use estuarine habitat, including swallows, kingfishers, common yellowthroats, song sparrows, and red-winged blackbirds, would benefit from an increase in estuarine habitat. However, the conversion of freshwater to estuarine habitat would negatively affect some passerine and nonpasserine species that primarily use freshwater and grassland habitats. Freshwater wetlands that would remain under Alternative C would be smaller than under Alternative B, but improved management in a smaller area may reduce the effects of estuarine restoration and create slightly higher carrying capacities and diversity of bird species using the Refuge wetlands. The removal of dikes and the loss of associated trees and shrubs on dike banks would reduce this type of edge habitat for some passerines and nonpasserines, including song sparrows, American robins, and northern flickers. The effects of this loss would be partially reduced by native plantings along new external and internal dikes, where appropriate, although it would take some time for plantings to mature. Portions of dike bank vegetation may remain along the Nisqually River, where they are protected by wider corridors of riparian vegetation.

Riparian restoration along the Nisqually River would create high quality riparian habitat for many passerine and nonpasserine species. This continuous 38-acre area would provide higher quality foraging and nesting habitat than narrow riparian areas that would occur along the dike in Alternatives A and B. Allowing the Nisqually River to flow more naturally and to move during high flow or flood events may reduce erosion and loss of riparian habitat, which could benefit many passerine species that depend on this habitat. In addition, riparian habitat enhancement within the freshwater wetland units would provide more habitat for passerines and nonpasserines. These restoration efforts would support a conservation management priority (riparian restoration) identified in this region in the Conservation of Land Birds Plan (Pashley et al. 2000). Species that may benefit from riparian forest restoration include the willow flycatcher, yellow warbler, downy woodpecker, and Swainson's thrush.

The loss of grassland areas under Alternative C is greater than under Alternative B and would adversely affect passerines that predominantly use this habitat. However, improved management

of these areas adjacent to freshwater wetland areas and the improved control of reed canary grass could help reduce the effects of the loss of grasslands.

Refuge Expansion

Effects to Waterfowl, Waterbirds, Seabirds, Shorebirds, and Landbirds

The effects of Refuge expansion on waterfowl, waterbirds, seabirds, shorebirds, and landbirds under Alternative C would be the same as those described under Alternative B. Acquisition of freshwater wetlands and grasslands south of I-5 could provide for some of the habitat lost to estuarine restoration, reducing the effects from the conversion of freshwater wetlands and grasslands to estuarine habitat. Birds that depend on freshwater wetlands could greatly benefit by expansion and restoration in the Nisqually Valley.

Public Use Program

Effects to Waterfowl, Waterbirds, Seabirds, Shorebirds, and Landbirds

Effects to various bird species from activities associated with the recreational trail system would be similar to those described in Alternatives A and B. Although the trail system would be reduced from 5½ miles to 3¾ miles, effects would be greater for waterfowl, waterbirds, and shorebirds that use habitats within the proposed new loop trail around the northern half of the freshwater wetland units. High public access of this area could have localized negative effects on waterfowl, waterbirds, and shorebirds that use the area to forage or rest. These effects would be the greatest of all the alternatives because it is the only alternative that includes a loop trail around such a small area (approximately 500 acres). However, requirements to stay on trails would reduce disturbance. Habitat improvements and vegetative screening would be designed to provide buffers to wildlife. The estuary boardwalk segment under this alternative could also affect waterfowl and shorebirds using the areas adjacent to the boardwalk. Boardwalks can affect waterfowl through hiker-induced shadows, noise, and movement (Josselyn et al. 1989). In addition, the EE program would be increased to serve up to 15,000 students. Disturbances to wildlife using habitats adjacent to the trail system would be higher than Alternative A but not as great as Alternative B. However, as described in Alternative B, the program would be designed to minimize effects and localize disturbances.

Trails in Alternative C include a 2½-mile trail east of the Nisqually River. This new trail would take the public into an area that has had a lower level of human activity. This higher presence could disrupt waterfowl and other waterbirds that use the area, including Canada geese, American wigeon, and bufflehead. The introduction of a trail along the East Bluff, under Alternative C (and D), may also lead to effects in an area that currently has no trails. Many landbird species use the forested East Bluff habitats and would be disturbed by trail activity. These effects would again be reduced by requirements to stay on trails. Trail design and vegetative screening would reduce disturbance.

Alternative C would alter current hunting conditions by consolidating the hunting area in the delta to a 1,170-acre block, opening Refuge lands to hunting, and adding Refuge management of hunting activities and implementing a 3 day per week hunting season and a 25-shell limit. The

hunting area would be a single block with easily identified boundaries, focusing all hunting activity in the tideflats and open water areas just north of the Brown Farm Dike. This would remove all hunting activity from McAllister Creek and the RNA. The habitat along McAllister Creek is a relatively narrow tidal system that receives high use by a variety of waterfowl, waterbirds, and raptors. Hunting affects the duration and pattern of use by wildlife in this narrow system. Discontinuation of hunting in the Creek would reduce disturbance to waterfowl and waterbirds, as well as to nesting bald eagles in the early part of the season (January). In addition, the 3 day/week hunt period would allow more wildlife use in hunt areas during non-hunt days. However, the lack of a seasonal trail closure along McAllister Creek would create localized disturbance to some waterfowl and waterbirds, but this effect would be limited to the vicinity of the trail. Hunting also causes safety conflicts with trail or boardwalk use along McAllister Creek. This alternative would eliminate these conflicts. As described in Alternative B, enforcement of the RNA closures and elimination of unauthorized hunting would be an improvement over Alternative A, as wildlife disturbances would decrease for waterfowl, waterbirds, seabirds, and shorebirds. However, the modification of the western RNA boundary reduces the RNA from 793 acres to 627 acres, decreasing RNA sanctuary area for waterfowl using the estuarine habitats. New estuarine sanctuary areas would be established in the estuarine restoration site.

Boating restrictions under all action alternatives would be expected to have positive effects on waterfowl, waterbird, seabird, and shorebird species that use the estuary, Nisqually River, and McAllister Creek, as described in Alternative B.

4.4.1.4 Alternative D (Preferred Alternative)

Habitat Restoration

Effects to Waterfowl, Waterbirds, Seabirds, and Shorebirds

Waterfowl, waterbird, seabird, and shorebird species that use the estuary would benefit from the restoration actions under Alternative D, similar to those described under Alternative C. However, since the restoration of full tidal conditions in the intertidal and river delta habitats would be over a larger area, benefits to estuarine-dependent avian species would be the greatest of all the alternatives. The inclusion of the McAllister Creek slough system (Shannon Slough) would improve the diversity and function of the estuarine habitat more than Alternative C. The restoration of the McAllister Creek slough system would increase the area of dynamic river/ tideflat interaction. In general, tidal freshwater is utilized by more avian species than any other wetland type (Mitsch and Gosselink 1993). Waterfowl would be expected to heavily utilize the large, restored estuarine habitat under Alternative D due to their documented use of estuarine habitat at the Refuge (Klotz et al. 1978).

Since the estuarine habitat restoration relative to other alternatives would be more sustainable and natural in terms of tidal flow and sediment accretion (see Section 4.1.4), this alternative would provide the highest quality of estuarine habitat than any other alternative and would be expected to produce the most complex and productive intertidal habitat. This alternative includes the strongest management activity to support the estuarine restoration priority for

shorebird and waterfowl management identified in the Pacific Coast Joint Venture Strategic Plan (Pacific Coast Joint Venture 1996) and the Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000). Restoration activities outlined in the plans include the "restoration of tidal regimes to diked wetlands in estuaries."

Species that predominantly use freshwater or grassland habitats would be most negatively affected by Alternative D because the largest acreage (699 acres) would be converted to estuarine habitat. Effects would be similar to those described in Alternatives B and C, although to a greater extent. The control of reed canary grass could be done most intensively under this alternative because of the smaller acreage, helping to compensate for the reduced total acreage of freshwater and grassland habitat (see Section 4.2.4). Since large portions of the wetland areas that would be converted are currently dominated by reed canary grass, their value to waterfowl is low (Maia 1994). The improved habitat management strategies in this alternative would result in higher quality freshwater wetlands available per acre for waterfowl, waterbirds, and shorebirds.

Effects to Landbirds

Raptors

Effects to raptors under Alternative D would be similar, although greater, than described for Alternative C. Alternative D proposes the largest area of estuary restoration, with the most benefit for species that could forage in estuarine habitat, such as eagles, osprey, falcons, and northern harriers. Common prey species of these raptors, such as waterfowl, shorebird, and salmonid populations, are predicted to have the greatest benefit from this alternative.

Restoration of the river/tidal dynamics between the Nisqually River and McAllister Creek would promote a habitat type used by more avian species than other wetland habitat types (Mitsch and Gosselink 1993), potentially increasing the carrying capacity for species that forage on avian prey, such as eagles, small hawks, and falcons. Bald eagles would especially benefit from the incorporation of the McAllister Creek area as they forage and nest in this area.

Open grassland area conversions due to restoration efforts would be the greatest under Alternative D. This would have significant effects on raptors currently using these habitats, such as the red-tailed hawk and northern harrier. However, northern harriers also feed regularly in salt marsh areas and, thus, would be more able to shift from foraging in freshwater grasslands to the new estuarine habitat.

Passerines and Nonpasserines

The effects to passerine and nonpasserine birds under Alternative D would be similar to those described for Alternative C. The conversion of freshwater to estuarine habitat in this alternative would be the greatest with the largest effect on passerine and nonpasserine species that primarily use freshwater and grassland habitats, including savanna sparrows, finches, and meadowlarks. However, the improved management of the remaining 263 acres of freshwater wetlands would have a higher carrying capacity than under current conditions and thus would improve avian productivity, reducing these effects for some of these species.

Refuge Expansion

Effects to Waterfowl, Waterbirds, Seabirds, Shorebirds, and Landbirds

Alternative D would provide the largest increase in the Refuge boundary and thus would provide the greatest potential benefit to waterfowl, waterbirds, shorebirds, and landbirds. Proposed expansion efforts in this alternative would incorporate more freshwater wetland and riparian areas into the Refuge as compared to Alternatives B and C, providing increased freshwater wetland and grassland acreage, which could reduce the effects in the current Refuge boundary resulting from estuarine restoration. However, as described in Alternative B, since Refuge expansion may not occur immediately, benefits from protection or restoration of these lands may not simultaneously reduce the effects from estuarine restoration occurring on the Refuge north of I-5. Benefits to various bird species are similar to those described in Alternative B but are expected to be greater because more habitat would be protected and managed by the Service. In particular, a larger portion of riparian habitat would potentially receive greater protection under Alternative D, greatly benefitting many passerines, waterfowl, and waterbirds that use the river. Effects from the proposed expansion on the East Bluff are the same as described in Alternative B.

Public Use Program

Effects to Waterfowl, Waterbirds, Seabirds, Shorebirds, and Landbirds

Effects to various bird species from activities associated with the trail system in this alternative would be similar to those described in Alternative C. However, disturbance effects from the main trail are expected to be the least of all the alternatives because it is the shortest and is located along the edge of the freshwater and restored estuarine habitats. Since there would be no loop trail in the freshwater or estuarine habitats, disturbance from trail users would not be as great. Since the boardwalk extension along McAllister Creek would be seasonally closed to prevent conflicts with hunters on WDFW lands, localized disturbance from trail users to waterfowl and other waterbirds would be reduced slightly in the winter months. The effects from the proposed trail on the eastside and East Bluff are the same as described in Alternative C, as would the effects of environmental education.

Alternative D would open a limited amount of Refuge lands (191 acres) to waterfowl hunting, 7 days per week. Although this alternative has fewer acres of Refuge lands open to hunting, similar to Alternative B, all three State parcels would still be open to hunting. This would not eliminate the patchwork of State hunting lands across the delta, potentially contributing to patchy or fragmented habitat use by waterfowl and shorebirds since hunting can shift bird distributions away from hunting areas (Fox and Madsen 1997). However, the effects from a 7 day/week hunt would be reduced compared to current conditions (Alternative A) because of the smaller hunt area. As described in Alternative B, enforcement of the RNA closures would be an improvement over Alternative A, as disturbance would decrease for waterfowl, waterbirds, seabirds, and shorebirds. However, the modification of the western RNA boundary would reduce the RNA from 793 acres to 764 acres, resulting in a decreased RNA sanctuary area for waterfowl and shorebirds using the tideflats and salt marsh areas at the mouth of the Nisqually River. The increase in hunter-based human disturbance in the RNA would reduce sanctuary area for waterfowl and shorebirds using estuarine habitats.

The closure of shellfishing and other consumptive uses in the RNA under all action alternatives would protect shellfish populations and decrease habitat disturbance in these tidal areas; such protection would enhance waterbird and seabird prey availability. Fishing-based interruptions of waterbirds can be detrimental to waterbird distribution, abundance, and productivity (DeLong and Schmidt 1998). The removal of fishing along McAllister Creek would provide localized benefits to great blue herons that forage in this area; loss of foraging habitat is considered to be among the threats that led to the current listing of this species as a Washington State Priority Species. Other waterbirds and seabirds that would benefit from reduced human use of the McAllister Creek area include pied-billed grebe, horned grebe, bufflehead, and double-crested cormorant.

The effects of boating restrictions would be the same as described in Alternative B.

4.4.2 Effects to Mammals

4.4.2.1 Alternative A

Habitat Restoration

Effects to Land Mammals

Management of the grasslands and freshwater wetlands under status quo conditions would benefit land mammals. However, as described above in Section 4.4.1.1, benefits would be expected to improve marginally compared to current conditions, although it would be difficult to retain this improved status because of the continual and increasing challenge of maintaining the quality of the freshwater wetlands and grasslands within the diked area. The conversion of seasonally flooded wetlands to scrub-shrub habitat would negatively affect species such as Townsend voles and deer mice, prey species for raptors and coyotes. Grassland areas would remain relatively unchanged from current conditions and thus would continue to support mammals such as coyotes, deer, Townsend voles, deer mice, and shrews.

Effects to Marine Mammals

Marine mammals occur in the saltwater areas of the Refuge and thus would not be directly affected by habitat management actions in this alternative. However, the retention of the full diked system under Alternative A may still affect the existing estuary due to tidal mudflat erosion, artificial sediment accretion patterns, and impeded tidal function (see Section 4.2.1). The effects of the dike on the estuarine habitat could affect marine mammal forage species and reduce food resources.

Refuge Expansion

Effects to Land and Marine Mammals

Under Alternative A, no expansion of the Refuge boundary would occur. Indirect benefits to land and marine mammals would occur if efforts to strengthen watershed protection through

partnerships outside of the Refuge boundary were successful. Increased watershed protection would improve water quality and associated habitat.

Efforts to acquire in-holdings within the existing boundary would continue under all alternatives. Acquisition of in-holdings in the estuarine habitat would eliminate the fragmented management of estuarine areas within the delta, contributing to improved water and intertidal habitat quality, potentially enhancing conditions for marine mammal foraging in the intertidal zones of the Refuge. In addition, disturbance associated with unregulated human activities in these areas would be reduced or controlled, benefitting all mammals that use these areas.

Public Use Program

Effects to Land and Marine Mammals

Under Alternative A, the recreational trail system would continue to be used for hiking and wildlife observation. Although this activity could disturb some land mammals, especially those using habitats adjacent to trails, it is not expected to be significant. Disturbance effects along trails have been found to alter land mammal behavior and may decrease fitness for disturbed animals (Bowles 1995). Research has also shown that larger bodied mammals are disturbed at greater distances than small (Knight and Cole 1995). In addition, the primitive trail in the surge plain (common to all alternatives) could have negative effects on land mammals, primarily deer mice, mink, beaver, and river otter, that occur in this habitat, especially if visitors wander off trail into the habitat. However, as described in Section 4.4.1.1, effects from trail use would be reduced by a variety of provisions, including a 100-car maximum parking lot, requirement to have visitors stay on trails, designated sanctuary areas, and vegetative screening (plantings). Refuge outreach programs would emphasize responsible behavior of Refuge visitors and thus could lessen wildlife disturbance effects (DeLong and Schmidt 1998; Larson 1995).

Under all alternatives, the restriction of fruit harvesting would benefit some land mammals that use these resources for forage. The EE program under Alternative A would be limited, serving up to 5,000 students. Since activities associated with this program would focus on trails or within the Environmental Education Center, no significant effects to land mammals would be expected. However, as described above, some disturbance to land mammals can occur when large educational groups are using trails.

Under this alternative, hunting would occur as it does currently in the WDFW and Refuge tideflats. Hunting-based disruptions can disturb terrestrial mammals that use wetlands and estuary areas such as mink, beaver, and river otter. Boating activity associated with hunting could disturb marine mammals. Harbor seals are susceptible to disturbance and are easily scared from haul-out areas (Brueggeman 1992; Chapman and Feldhamer 1982). Human disturbance is one of the major causes of pup mortality and is believed to be among the reasons why the historical harbor seal breeding area at Nisqually is currently inactive (Boulva and McLaren 1979; Klotz et al. 1978). Harbor seal haul-out areas are a WDFW priority habitat and should be protected at Nisqually NWR. Human use of the Refuge as outlined under Alternative A could have higher incidents of haul-out site disruption than other alternatives. In addition, since this alternative would allow for continued access to the RNA, boating, unauthorized hunting, and fishing activities could affect marine mammals that use this area.

Human presence and disturbance associated with fishing may also limit the use of some areas by terrestrial mammals near the McAllister Creek fishing area. PWC use would continue under Alternative A. This activity would disturb species that use the rivers and estuarine areas such as mink and river otters. As described above (Section 4.4.1), many studies have shown that boating can have negative effects on wildlife through disruption of feeding and breeding activities (DeLong and Schmidt 1998).

4.4.2.2 Alternative B

Habitat Restoration

Effects to Land Mammals

Alternative B would create a limited amount of both muted estuarine and full estuarine habitats. In addition, freshwater wetlands and ponds would be increased and habitat quality improved in all Refuge freshwater wetlands.

The shift from freshwater to estuarine habitat would also shift species composition to favor estuarine-associated species. Initially, however, newly restored estuarine areas may be primarily composed of mudflats, providing minimal habitat for land mammals. Eventually, as salt marsh habitat becomes established, mammals such as river otter are expected to use the restored areas. However, as described above (Section 4.4.1), the ability of muted estuarine habitat to mimic the structure and function of a natural estuary is unknown; consequently, the benefits to these mammals are uncertain. In addition, under this alternative, fragmentation of the restored estuarine areas could interrupt small mammal passage through the habitat edges. The conversion of the diked area to estuarine habitat would negatively affect mammals that primarily use the grassland habitat, such as coyotes, deer, and shrews. Alternative B (and C) would have a somewhat smaller effect on land mammals that exclusively occur in the grassland or freshwater habitats because it has less area of estuarine restoration as compared Alternative D.

In the areas where freshwater wetlands would be converted to saltwater, a short-term vegetation die-back would decrease habitat availability temporarily until the system can convert to saltwater regimes (Harris and Marshall 1963). This would temporarily affect land mammals such as Townsend voles, deer mice, and river otters that are expected to use the estuaries, but eliminate habitat for those species that almost exclusively use freshwater and grassland habitats, such as beavers and deer. The freshwater habitat improvements would benefit mammal species that use this habitat, such as river otter, mink, and beaver.

Effects to Marine Mammals

Estuarine restoration under Alternative B would create a mix of full and muted estuarine habitats. This limited estuarine restoration would improve habitats used by marine mammals, especially harbor seal haul-out sites. It is uncertain how often seals and sea lions would use the muted estuary area. It would be expected that they would find and use breach sites if food resources were present inside the muted estuarine area. However, dikes would make access more difficult, requiring marine mammals to travel greater distances. Although harbor seals have been observed in McAllister Creek, it is uncertain how often marine mammals would utilize the restored full

estuary area due to its inland location. However, estuary improvements would extend into the full estuary areas connected to Puget Sound and thus benefit sea lions and seals to some degree.

Apart from estuary restoration, habitat management actions taken under Alternative B would not significantly affect marine mammals. Riparian and freshwater wetland improvements would slightly improve water quality entering into the tidal systems and thus could provide some benefit to marine mammals or their prey.

Refuge Expansion

Effects to Land and Marine Mammals

The expansion actions under Alternative B would include the proposed acquisition of lands along the East Bluff and south of I-5. This would increase protected wetland and riparian habitat areas and benefit land mammals that use riparian and freshwater habitats, including such species as mink, Townsend vole, river otter, and beaver. Acquisition of these areas would decrease habitat fragmentation, provide more continuous corridors, facilitating movement and access to a variety of habitats, benefitting mammals. Acquisition and restoration in the Nisqually Valley south of I-5 would reduce the effects of the conversion of freshwater wetlands within the current Refuge, benefitting many land mammal species. The increase in overall watershed protection under partnership building and area expansion may improve overall intertidal zone habitat quality, including water quality, which may have slight positive effects on marine mammals in the area.

Public Use Program

Effects to Land and Marine Mammals

Under all action alternatives, the Service would manage the Luhr Beach area if a cooperative management agreement can be developed with the State. Since this is a major access point for boaters, especially hunters and anglers, the installation of a Visitor Contact Station would increase visitor awareness and thus decrease disturbances from these recreational activities to marine mammals and other species using the delta.

Effects to land mammals from activities associated with the recreational trail system would be similar to those described under Alternative A, especially since the trail system in Alternative B is only slightly larger than in Alternative A. However, under Alternative B, the newly created full estuarine area would be encircled on three sides by a recreation trail. High public activity could have negative effects on mammals that use this habitat, including seals, mink, beaver, and river otter. However, requirements to stay on trails would localize disturbance. In addition, the EE program would be increased to serve up to 20,000 students per year, the largest expansion of the education program of all the action alternatives. Disturbances to wildlife using habitats adjacent to the trail system would occur. As described above, disturbance effects along trails can alter land mammal behavior and decrease fitness for disturbed animals (Bowles 1995). However, as described above, provisions and Refuge outreach programs would restrict activities, emphasize responsible behavior, and minimize wildlife disturbance effects.

Waterfowl hunting areas, as defined in Alternative B, would draw hunters away from the far reaches of the tideflats compared to Alternatives A and C, where marine mammals are mostly located. This would reduce disturbances to haul-out and foraging activities. The removal of unauthorized hunting on Refuge lands would benefit marine mammals, as well as land mammals that would otherwise be disturbed by the activity. However, the unconsolidated WDFW lands would lead to fragmentation of hunting-free areas, which could isolate seals. Under all action alternatives, the RNA would be posted and a no-hunting policy enforced. This would be an improvement over Alternative A, as disturbances would decrease for seals, river otters, and minks. The restriction of public access into the estuarine habitat under Alternative B (and C and D) through the closure of the RNA and protection of restored areas would benefit land and marine mammals that utilize this habitat. Species commonly observed in estuary areas include Townsend vole, deer mice, river otter, mink, and harbor seals. The restriction of public access into the restored estuarine habitat under Alternative B (and C and D) would also benefit all of the species described above.

Continued bank fishing along McAllister Creek, as allowed under Alternative B (and C), could disturb some seals. Boating restrictions under all action alternatives are expected to have positive effects on marine mammals, primarily harbor seals, that use the estuary, Nisqually River, and McAllister Creek. Boating restrictions under all action alternatives would improve estuarine habitat and decrease wildlife disturbance.

4.4.2.3 Alternative C

Habitat Restoration

Effects to Land Mammals

Similar to Alternative B, the conversion of freshwater to estuarine habitat under Alternative C would shift species composition to favor estuary-associated species, but to a larger degree and with no muted estuarine areas. Land mammals, such as river otter, Townsend vole, and deer mice, that use a variety of habitats including the salt marsh would benefit from restoration actions. The combination of estuarine, improved freshwater, and grassland habitats would provide more cover and habitat for prey species. River otter would significantly benefit, as they are the most abundant in estuarine systems (Chapman and Feldhamer 1982). The estuary restoration under Alternative C would have fewer edges than under Alternative B and thus could be more beneficial to land mammals that are easily affected by edge effects.

As described under Alternative B, the conversion of the diked area to estuarine habitat would negatively affect mammals such as coyote, deer, beaver, and shrew. The management of the remaining wetlands would be more intensive under Alternative C and thus could lead to a somewhat higher quality habitat with higher carrying capacities for these mammals than Alternative B. In addition, riparian restoration in the freshwater units and also the 38-acre area along the Nisqually River would benefit these same species. Riparian habitat restoration along the Nisqually River would create higher quality riparian habitat that could be used by land mammals.

Effects to Marine Mammals

Effects of estuarine restoration under Alternative C would be similar to those described for Alternative B, but to a greater extent. The estuary restoration under Alternative C would create a larger amount of fully functional estuarine habitat, primarily in the intertidal and riparian interaction zones, increasing the potential for marine mammal use of the habitat. Dikes would be removed, improving marine mammal passage.

Apart from estuary restoration, habitat management actions under Alternative B would not significantly affect marine mammals. Riparian and freshwater wetland actions would improve water quality entering into the tidal systems and thus provide some benefit to marine mammals or their prey.

Refuge Expansion

Effects to Land and Marine Mammals

Refuge expansion would be identical in Alternatives B and C, so the effects to mammals would be the same.

Public Use Program

Effects to Land and Marine Mammals

Effects to mammal species from activities associated with the recreational trail system would be similar to those described in Alternative B, except for the new loop trail within the freshwater area. High public activity on this loop trail could have negative effects on land mammals using this area. This effect is expected to be larger than under Alternatives A or B because the area within the loop trail would be much smaller; thus, sanctuary areas away from human activity would be reduced in size. The EE program would be smaller than in Alternative B; thus, effects on mammals would be somewhat less.

The establishment of a new trail on the east side of the Nisqually River would cause localized disturbance to mammals using those habitats. This trail would affect wetland and upland mammal communities, possibly affecting such species as river otter, deer, coyote, mink, long-tailed weasel, and others. In addition, the introduction of a boardwalk trail near McAllister Creek would affect species utilizing the newly restored estuary, such as river otters and harbor seals. However, as described in Section 4.4.1.1, effects from trail use would be reduced by a variety of provisions and Refuge outreach programs.

Human presence and disturbance associated with hunting under Alternative C would be restricted to a rectangular block north of the diked area. These hunting areas would have the least potential effects to marine mammals compared to all other alternatives because of the limited area and improved ability to post and delineate boundaries. Boating restrictions under Alternative C would be similar to those outlined under Alternative B, decreasing habitat disturbance and benefitting marine mammals.

4.4.2.4 Alternative D (Preferred Alternative)

Habitat Restoration

Effects to Land Mammals

Effects to land mammals under this alternative would be similar to those described in Alternative C. However, Alternative D would convert the largest amount of diked area to estuarine habitat. Land mammals that largely use freshwater and grassland areas would be most negatively affected under Alternative D, including coyotes and deer. Edge effects and habitat fragmentation are limited under this alternative and thus would benefit mammal species.

The remaining 263 acres of freshwater wetlands would benefit from intensive management and thus would have a higher carrying capacity (per acre) than under current conditions. Higher capacities would reduce effects on terrestrial mammal productivity for beaver and mink, among other species.

Effects to Marine Mammals

Effects to marine mammals in Alternative D would be the most beneficial because it would provide the largest area of estuary restoration, without dikes to act as potential barriers. The restoration of full tidal conditions in this larger area would provide a larger and more productive foraging area.

Habitat management actions other than estuary restoration activities would have limited effects on marine mammals. Riparian and freshwater wetland improvements would improve water quality entering the tidal systems and thus could provide some benefit to marine mammals or their prey.

Refuge Expansion

Effects to Land and Marine Mammals

In addition to effects described in Alternatives B and C, 3,479 acres are proposed for Refuge expansion. This expansion would protect additional floodplain habitat and Nisqually River riparian corridor south of I-5. This would provide the greatest benefit to land mammals that use riparian and freshwater habitats, including species such as mink, Townsend vole, river otter, and beaver. Acquisition of these areas would decrease habitat fragmentation and have larger potential benefits to mammalian species. The increase in acreage under this alternative would be especially beneficial to large-bodied terrestrial mammals such as deer and coyote as they have larger territorial ranges. Expansion actions in Alternative D would have minor positive effects for marine mammals. The increase in overall watershed protection under partnership building and area expansion may improve overall intertidal zone habitat quality, including water quality, which may have slight positive effects on marine mammals in the area. For example, the increased protection of the Nisqually River corridor may improve conditions for large woody

debris recruitment and subsequent deposition on Refuge mudflats. This type of woody debris could be utilized by marine mammals, particularly as harbor seal haul-out sites.

Public Use Program

Effects to Land and Marine Mammals

Effects to mammal species from activities associated with the recreational trail system would be similar as described in Alternative C but to a lesser extent, because the main trail in this alternative is the shortest and is located along the edge of the freshwater and restored estuarine habitat. Since there is no loop trail in the freshwater or estuarine habitats, disturbance from trail users would not be as great. The effects from the proposed trail on the eastside and East Bluff are the same as described in Alternative C, as well as the effects of the EE program.

Alternative D proposes to open a limited amount of Refuge lands (191 acres) to waterfowl hunting. Although this alternative has less acres of Refuge lands open to hunting, all three State parcels would still be open to hunting, similar to Alternative B. This would not eliminate the patchwork of State hunting lands across the delta, contributing to disturbances to marine mammals. Like Alternative A, the tideflats would be open to hunting and would focus along the primary marine mammal haul-out habitat. As described under Alternative B, enforcement of the RNA closures would be an improvement over Alternative A, decreasing disturbance to marine mammals. However, the modification of the western RNA boundary would reduce the RNA from 793 acres to 764 acres, decreasing sanctuary area for marine mammals using the tideflats and salt marsh areas at the mouth of the Nisqually River.

Boating restrictions under Alternative D would be similar to those outlined under Alternative B, decreasing habitat disturbance and benefitting marine mammals. Fishing and shellfishing effects on mammals under Alternative D would be similar to Alternative C, except that disturbance to mammals associated with bank fishing along McAllister Creek would not occur.

4.4.3 Effects to Reptiles and Amphibians

4.4.3.1 Alternative A

Habitat Restoration

The retention of the freshwater and estuary wetlands under existing conditions would support existing amphibian and reptile species. However, the continued conversion of shallow wetlands to scrub-shrub habitat would decrease open water and seasonal wetlands, adversely affecting many species of frogs and salamanders that rely on open freshwater for breeding habitat. Dike repair work may increase short-term sedimentation and negatively affect amphibians, which are very sensitive to water quality (Kauffman et al. 2001). Grassland areas would continue to support reptiles currently using these habitats, although habitat quality would deteriorate as reed canary grass spreads. Estuary and freshwater wetland habitats would be expected to deteriorate under this alternative and would negatively affect amphibian and reptile species in the long term.

Refuge Expansion

Under Alternative A, no expansion of the Refuge boundary would occur. Indirect benefits to amphibians and reptiles would occur if efforts to strengthen watershed protection through partnerships outside of the Refuge boundary were successful. Increased watershed protection would improve water quality and associated habitat.

Efforts to acquire in-holdings within the existing boundary would continue under all alternatives. These actions would benefit reptiles and amphibians through a decrease in habitat fragmentation and edge effects caused by different land management practices.

Public Use Program

The current trail system would remain under Alternative A. In addition, a ½-mile surge plain trail would be developed. Activity on trails may result in minor effects to amphibians and reptiles in several ways, including noise interruptions and disturbances to habitat on some trails. However, as described above, provisions and Refuge outreach programs would restrict trail users and emphasize responsible behavior, minimizing wildlife disturbance effects (DeLong and Schmidt 1998; Larson 1995).

Boating and PWC use under Alternative A would not be expected to affect amphibians and reptiles as boating occurs primarily in saltwater areas, habitat not used by these species.

4.4.3.2 Alternative B

Habitat Restoration

The shift from freshwater to estuarine habitat would decrease habitat for amphibians, which are associated with seasonal freshwater ponds. A total of 458 acres of potential amphibian and reptile habitat would be lost, including breeding habitat for many salamanders and frogs.

The 542 acres of freshwater habitat improvements would benefit amphibian and reptile species. The extent of benefits for amphibians would depend on the flow and fluctuation regime, which determines species richness in Puget Sound wetlands (Richter and Azous 1995). Generally, lower flow and smaller fluctuation events increase species diversity (Richter and Azous 1995). If high and permanent flows are allowed under the wetland management actions of Alternative B (or C or D), bullfrogs may have an advantage (Adams 1999). Bullfrog abundance in freshwater wetlands may have significant adverse effects on native frogs due to predation (Leonard et al. 1993). Control of water flow and levels would be limited in Alternative B and may not provide high quality habitat for amphibians.

In addition to flow and water regimes, the quality of vegetation in and around freshwater wetlands managed under Alternative B (and C and D) would affect amphibians. This is because vegetation affects water temperature, which influences the breeding success of frogs and salamanders (Richter 1995). Specific plant species are associated with spawning activities of

particular amphibian species (Richter 1995). The ability to restore or mimic natural conditions would determine the benefits for amphibian species.

Refuge Expansion

The expansion actions under Alternative B would include the proposed acquisition of lands along the East Bluff and south of I-5. This would increase protected wetland and riparian habitat areas and benefit amphibians that use riparian and freshwater wetland habitats, including red-legged frogs and salamanders. Acquisition and restoration of these areas would decrease habitat fragmentation and have larger potential benefits to amphibians. Furthermore, additional protection in areas outside of the current Refuge boundary may allow for the conservation of smaller wetlands that would not otherwise receive protection. Small wetlands are important to local amphibian diversity and abundance (Richter and Azous 1995). Management of these small wetlands could include maintaining open seasonal wetland habitats similar to agricultural lands that are currently grazed with a higher proportion of seasonal ponding. In addition, acquisition and protection of freshwater wetland habitats would support potential re-introduction projects associated with the western pond turtle or Oregon spotted frog.

Public Use Program

The trail system would change slightly in Alternative B. As described above, activity on trails may affect amphibians and reptiles in several ways; however, effects are expected to be minor. Boating restrictions under Alternative B would not be expected to affect amphibians and reptiles as these activities occur in saltwater areas.

4.4.3.3 Alternative C

Habitat Restoration

Effects from restoration activities under Alternative C would be similar but greater than described for Alternative B since a larger amount of diked area would be converted to estuarine habitat. Remaining freshwater wetlands and riparian areas would be significantly improved over current conditions.

The larger shift from freshwater to estuarine habitat under Alternative C would decrease habitat acreage for amphibians. The management of the remaining wetlands would be more intensive under Alternative C and may lead to higher carrying capacities for amphibians and reptiles using this habitat. Better control of water flow and levels, resulting in a higher proportion of seasonal wetlands, would provide higher quality habitat for native amphibians instead of bullfrogs. Riparian restoration along the Nisqually River would create higher quality riparian habitat for species such as red-legged frogs, Pacific tree frogs, and garter snakes.

Refuge Expansion

Refuge expansion would be identical in Alternatives B and C; the effects to reptiles and amphibians would be the same.

Public Use Program

As described above, activity on trails may affect amphibians and reptiles in several ways. The effects from trails in Alternative C would be similar but fewer than under Alternative B. However, the potential development of a trail on the eastside and East Bluff trail would cause localized disturbance to species using those habitats.

4.4.3.4 Alternative D (Preferred Alternative)

Habitat Restoration

Restoration and management actions under Alternative D would provide the largest area of estuarine habitat and the greatest reduction of freshwater wetlands, representing the greatest decrease in habitat for amphibians and reptiles. A total of 699 acres of amphibian and reptile habitat would be lost, including breeding habitat for many salamanders, frogs, and garter snakes. Across the region, the isolation and loss of wetlands is thought to have led to decreases in many amphibian species (Richter and Azous 1995).

Management of the remaining freshwater wetlands would be the most intensive under Alternative D and may lead to higher carrying capacities for amphibians and reptiles using this habitat. Better control of water flow and levels, resulting in a higher proportion of seasonal wetlands, would provide higher quality habitat for native amphibians instead of non-native bullfrogs. Freshwater wetlands and riparian areas would be significantly improved over current conditions. Similar effects would result from the riparian restoration along the Nisqually River, as described in Alternative C.

Refuge Expansion

Alternative D proposes a 3,479-acre Refuge expansion, which would provide the greatest benefit to reptiles and amphibians of the action alternatives. Benefits include decreased habitat fragmentation as well as increased habitat protection, especially along the Nisqually River corridor. Habitat connectivity within riparian corridors is especially beneficial to amphibian species (Richter 1995). Protection and restoration of freshwater wetlands in the Nisqually Valley would also significantly benefit native amphibians and reptiles.

Public Use Program

Effects from recreational activity associated with trails would be similar to all other alternatives but with fewer effects because Alternative D proposes the smallest trail system.

4.4.4 Effects to Invertebrates

4.4.4.1 Alternative A

Habitat Restoration

Although invertebrate species composition is not well known, many species occur in freshwater habitats, providing food for a variety of wildlife; these species would benefit from the continued existence of freshwater wetlands within current the Refuge boundary. Freshwater wetlands would likely deteriorate over time due to current and ongoing exotic species invasions and slow gradual conversion to scrub-shrub communities. This gradual reduction in habitat diversity would reduce habitat quality for terrestrial invertebrates.

In addition, the current dike system is not stable and would require major repairs. Repair work may increase short-term sedimentation and thus negatively affect invertebrates that are very sensitive to water quality (Karr et al. 1986).

Refuge Expansion

Under Alternative A, no expansion of the Refuge boundary would occur. Indirect benefits to invertebrates would occur if efforts to strengthen watershed protection through partnerships outside of the Refuge boundary were successful. Increased watershed protection would improve water quality and associated habitat.

Efforts to acquire in-holdings within the existing boundary would continue under all alternatives. These actions would benefit invertebrates through the decrease in habitat fragmentation and edge effects caused by different land management practices.

Public Use Program

The current trail system would remain under Alternative A. In addition, a ½-mile surge plain trail would be developed. Trails and associated activity may have some minor localized effects on invertebrates due to soil compaction, trampling, and barriers to movement.

Boating, PWC use, hunters, and anglers moving through the Refuge could cause localized disturbance, particularly to aquatic invertebrates in the mudflats. Negative effects on aquatic invertebrates may also be caused by water pollution and turbidity from boats and PWC. In addition, shellfishing directly affects marine invertebrates through collection and habitat disturbance. This would especially affect the RNA area, which is an important area for marine invertebrate production.

4.4.4.2 Alternative B

Habitat Restoration

Invertebrate species that use estuarine habitats would benefit from restoration actions. The extent of this benefit would depend on the use of the muted estuarine area. Similar to other wildlife species, there is uncertainty regarding relative abundance in muted estuarine habitat. Amphipods use both fresh and saltwater systems in the Pacific Northwest and would be expected to use the muted habitat (Cordell et al. 1999). Species that may use the fully restored estuary include ghost shrimp, bivalves, polychaetes, spionids, and nematodes. The benefits from all estuarine restoration, both muted and full, under Alternative B would not be as great as those under Alternatives C and D.

The conversion of fresh to saltwater systems would shift invertebrate species composition to those that favor estuary systems. Invertebrate species exclusively found in freshwater and grassland habitats would be affected by the elimination of habitat. However, the freshwater habitat improvements for areas that remain would provide a higher quality of habitat for various invertebrate species.

The management of current grassland habitat would benefit terrestrial invertebrates, such as insect populations. These species currently concentrate in Refuge pastures and upland habitats and would continue to do so under this alternative. The maintenance and creation of dike systems and other management actions may increase sedimentation in the short term immediately after construction activities. This could negatively affect aquatic invertebrates through decline in water quality (Waters 1995).

Refuge Expansion

Expansion under Alternative B would include the proposed acquisition of lands along the East Bluff and south of I-5. This would benefit invertebrates that use riparian and freshwater habitats. Acquisition and restoration of these areas would decrease habitat fragmentation and increase habitat quality. Improved protection of the East Bluff forest may improve water quality (see Section 4.2.4) and thus benefit the diversity of marine invertebrates that use estuarine habitats.

Public Use Program

Under all action alternatives, the Service would manage the Luhr Beach area if a cooperative management agreement is developed with the State. Since this is the major access point for boaters, including hunters, anglers, and shellfishermen, the installation of a Visitor Contact Station here would decrease disturbances to invertebrates and their habitat through education.

Public access restrictions in the RNA and the closure of restored areas under Alternatives B (and C and D) would lessen disturbance to marine invertebrates and their habitat. Alternative B would provide trail access similar to Alternative A and thus would have similar effects on invertebrates. Boating, hunting, and fishing could cause localized disturbance to marine invertebrates through trampling, direct collection, and soil compaction. In addition, under all the

action alternatives, the RNA would be posted, and a no consumptive use policy and winter boat closures would be enforced. This would decrease disturbance to marine invertebrates. Boating restrictions under Alternative B would benefit marine invertebrates by decreasing effects to water quality.

4.4.4.3 Alternative C

Habitat Restoration

Alternative C would establish a larger (515-acre) area of estuarine habitat than Alternatives A and B, while maintaining and enhancing 447 acres of freshwater wetlands.

The restoration of full tidal conditions in the intertidal and river delta habitats would benefit marine invertebrates that use this area, such as bivalves and gastropods, opisthobranches, and amphipods. This alternative would restore a continuous estuary, eliminating fragmentation associated with the muted estuary provided in Alternative B.

Effects to invertebrates associated with freshwater wetlands and grasslands in Alternative C would be similar to those described in Alternative B. The decrease in edge and increase in habitat connectivity under Alternative C may lead to higher quality habitat than under Alternative B. Riparian restoration along the Nisqually River would create higher quality riparian habitat that could be utilized by terrestrial and aquatic invertebrates.

Refuge Expansion

The environmental consequences for Refuge expansion under Alternative C would be the same as those described for Alternative B.

Public Use Program

Effects of the public use program would be similar to Alternative B. Trail-based effects on invertebrates would be less under this alternative than under Alternatives A or B, as the trail system would be reduced from 5½ miles to 3¾ miles. The additional boardwalk trail may have localized effects on marine invertebrates due to shading under the boardwalk; however, the effects are not well known.

Fishing and shellfishing effects on invertebrates under Alternative C would be similar to Alternative B. Localized effects by hunting activity would be over a single block of lands and not in McAllister Creek, compared to Alternative B.

4.4.4.4 Alternative D (Preferred Alternative)

Habitat Restoration

Alternative D would involve the largest area (699 acres) of estuarine habitat restoration and greatest reduction of freshwater wetlands. The inclusion of the McAllister Creek area would

improve the diversity and function of estuarine habitat compared to Alternative C, leading to greater positive effects to marine invertebrates. Estuary systems are considered some of the most productive habitats in the world, largely due to the abundance of invertebrates. Increases in marine invertebrates would provide more food for many fish and wildlife species.

The conversion of freshwater wetlands under Alternative D would be the largest of all alternatives, causing the largest shift in the invertebrate community. Invertebrates exclusively dependent on freshwater and grassland habitats would be most affected by this alternative, thereby reducing potential food sources for wildlife that forage heavily on those invertebrate species. The effects of riparian management under Alternative D would be similar to those described for Alternative C.

Refuge Expansion

The proposed expansion area in Alternative D would provide the greatest benefit to invertebrate species compared to the other alternatives, especially in areas south of I-5 in the Nisqually Valley and along the Nisqually River. Land protection and restoration could increase invertebrate abundance and diversity.

Public Use Program

Effects of the public use program would be similar to Alternatives B and C. Effects from trails under Alternative D would be somewhat less in localized areas due to the reduced length of trails.

Human presence and disturbance associated with resource harvesting (hunting, fishing, and shellfishing) are expected to be similar to Alternative B, except for a slightly larger hunting area that includes the mouth of the Nisqually River.

4.4.5 Effects to Invasive and Exotic Wildlife Species

4.4.5.1 Alternative A

Habitat Restoration

Long-term resource monitoring under all alternatives would help control exotic species by better documenting species presence and abundance. Conservation planning requires a long-term commitment to ecological monitoring (Noss et al. 1997). With these data in hand, the Service could manage invasive species more effectively.

Restoration of the West Bluff parcel (under all alternatives) would improve native vegetation diversity and habitat quality, potentially reducing the use by non-native wildlife species that tend to use disturbed areas.

Mitten and green crabs would continue to pose a potential threat if they eventually invade the estuary. The limited improvements in freshwater habitats under this alternative would allow

bullfrogs to continue to increase, causing direct negative effects on native amphibian production. Large numbers of European starlings would continue to roost, feed, and nest on the Refuge, competing with native birds for feeding and nesting habitat.

Refuge Expansion

Completion of acquisition within the boundary and strengthened partnerships within the watershed under all alternatives would reduce habitat fragmentation and improve connectivity between habitats. These characteristics would otherwise make habitats more susceptible to exotic species invasions (Meffe and Carroll 1994). However, these actions taken under Alternative A would have small adverse and/or neutral effects on exotic species, such as bullfrogs and European starlings resulting in less benefit to native species compared to the action alternatives.

Public Use Program

The public use program would not be expected to significantly affect exotic wildlife species under Alternative A, except that some low potential would exist for undesirable releases of non-native species onto the Refuge. Boats or PWC could inadvertently introduce or speed the spread of aquatic wildlife exotics, such as crab and other invertebrate species.

4.4.5.2 Alternative B

Habitat Restoration

Under Alternative B, 45% of the currently diked wetlands would be converted to estuarine habitat. The reduction in grasslands may provide less habitat for European starlings, but the effect may not significantly change numbers. Increased estuarine habitat would provide a greater area for potential invasion and spread of mitten and green crabs. Improved freshwater habitat quality and a higher proportion of seasonal wetlands could reduce bullfrog habitat, benefitting native amphibians. The extent of this benefit would depend on water flow and fluctuation levels. For example, bullfrogs in western Washington have been documented to benefit from the increase in protection of permanent water wetlands (Adams 1999). Thus, the permanence of the water in the managed wetlands created under Alternative B (and C and D) would affect the success of bullfrogs at Nisqually NWR.

Refuge Expansion

Expanded acquisition and restoration proposed in Alternative B would encourage native wildlife species and reduce habitat for exotic wildlife species, including bullfrogs and starlings, on a greater scale than in Alternative A. Native species would benefit.

Public Use Program

Effects from the public use program are similar to those described under Alternative A.

4.4.5.3 Alternative C

Habitat Restoration

Estuary restoration under Alternative C would be larger than Alternative B; thus, the potential for mitten and green crab establishment would be increased.

The reduction in grasslands under Alternative C would provide the same effects as described in Alternative B. Improved freshwater habitat quality and a higher proportion of seasonal wetlands could reduce bullfrog habitat, benefitting native amphibians.

Refuge Expansion

Effects to exotic species would be the same as those described under Alternative B.

Public Use Program

Effects to exotic wildlife species under this alternative would be similar to those described for Alternative B.

4.4.5.4 Alternative D (Preferred Alternative)

Habitat Restoration

Effects from restoration activities would be similar to Alternative C, except that the amount of estuarine restoration would be the greatest of all the alternatives. Restoration of the estuary under Alternative D would greatly benefit native species that use this habitat. There would be a larger area that mitten and green crabs could invade, but the higher habitat quality in Alternative D may slow the spread. The remaining freshwater wetlands would have the most intensive restoration and management of all alternatives considered. The reduction in grasslands may reduce habitat for starlings. Less permanent freshwater areas would discourage bullfrogs and benefit native amphibians.

Refuge Expansion

The proposed expansion area in Alternative D would provide the largest potential for exotic species reduction of all alternatives, the result of improved riparian and freshwater wetland protection and restoration (see Section 4.2.1). This alternative would include habitat quality improvements that would enhance conditions for native species and strengthen competitive abilities against exotic species. Habitat expansion and improved habitat quality could improve conditions for native cavity-nesting birds in riparian habitat along the Nisqually River, which may lessen the effects of European starlings. Acquisition, restoration, and management of freshwater wetlands south of I-5 would be greatest under Alternative D, which could reduce bullfrog populations and benefit native amphibians.

Public Use Program

Effects of the public use program would be similar to Alternatives B and C.

4.4.6 Effects to Threatened and Endangered Species and Selected Birds of Conservation Concern

See Section 4.3.5 for details on the effects to fish species.

4.4.6.1 Alternative A

Habitat Restoration

The restoration of the West Bluff parcel under all alternatives would enhance bald eagle nesting habitat quality (see Section 4.4.1.1). As described in Section 4.2.1, the persistence of the current dike system may still affect the existing estuary due to tidal mudflat erosion, artificial sediment accretion patterns, and reduced tidal prism. Degradation of estuarine habitat over time and lack of restoration would provide no new benefits to Steller sea lions, brown pelicans, or marbled murrelets.

Freshwater wetland improvements under this alternative are not expected to enhance current wetland habitat quality over the long-term. Seasonal freshwater wetlands would deteriorate over time due to exotic species invasion, resulting in a conversion to scrub-shrub communities. Increased conversion to reed canary grass infringement would significantly decrease seasonal wetland habitat used by waterfowl and waterbirds. This would provide lower food resources for eagles and not contribute to meeting Refuge goals.

Refuge Expansion

All threatened and endangered species (TES) would benefit, although not significantly, from more uniform land protection and conservation within the Refuge. Strengthened partnerships would increase water and intertidal habitat quality, providing some benefits in foraging conditions for salmon, bull trout, sea lion, pelican, and murrelet. See Section 4.4.1.1 for a description of effects on bald eagles.

Public Use Program

Under Alternative A, the trail system would continue to be used for hiking and wildlife observation. Although these activities could have negative effects on TES, especially those using habitats adjacent to trails, they would not be expected to be significant. The reduction in human disturbance along the western shoreline of McAllister Creek would benefit bald eagles. Since activities associated with the EE program would be focused on trails or within the Environmental Education Center, no significant effects to TES are expected.

Under this alternative, hunting would occur as it does currently in the WDFW and Refuge tideflats. The presence and associated activity of hunters, anglers, and boating activity in the

estuary, including the RNA, would disturb TES species that use this habitat and are sensitive to disturbance. TES seabirds and marine mammals concentrate in the outer reaches of the Refuge; thus, the lack of closure of the RNA to resource harvesting and winter boating would allow these disturbances to continue. See Sections 4.4.1.1 and 4.4.2.1 for a description of the effects to bald eagles, seabirds, and marine mammals.

Under Alternative A, boat and PWC use would continue. Many TES species, including Steller sea lions and marbled murrelets, are known to be affected by boats (Boersma and Parrish 1998; Brueggeman 1992). High speed watercraft would have the greatest effects.

4.4.6.2 Alternative B

Habitat Restoration

Estuarine restoration under Alternative B would improve the quality and increase the quantity of estuarine habitats along the northern edge of the diked area and McAllister Creek, benefitting Steller sea lions, marbled murrelets, bald eagles, and brown pelicans. However, short-term adverse effects associated with reduced water quality resulting from construction activities, such as dike breaching and bridge construction, may occur. Estuarine restoration would also benefit shorebirds of conservation concern, such as the whimbrel, marbled godwit, red knot, and short-billed dowitcher (USFWS 2001). See Sections 4.4.1.2, 4.4.2.2, and 4.3.2 for a description of the effects to bald eagles, seabirds, shorebirds, marine mammals, and fish. The benefits from estuary restoration (both muted and full) under Alternative B would not be as great as under Alternatives C and D because the restoration areas would be fragmented with edges. In addition, it would be more difficult for marine mammals and fish to move in and out of diked restoration sites. Improved management of the freshwater wetland and riparian areas would benefit bald eagles, great blue herons, and Birds of Conservation Concern (BCC) listed shorebirds and landbirds (e.g., rufous hummingbird, olive-sided flycatcher).

Refuge Expansion

Effects of increased watershed protection would be the same as described under Alternative A. However, Alternative B expansion activities would benefit TES species more than under Alternative A. The protection of additional habitat along the East Bluff and floodplains south of I-5 would benefit bald eagles as well as shorebirds and landbirds on the BCC list (USFWS 2001). See Sections 4.4.1.2, 4.4.2.2, and 4.3.2 for a description of effects to bald eagles, seabirds, shorebirds, marine mammals, and fish.

Public Use Program

Under all action alternatives, the Service would manage the Luhr Beach area, if a cooperative management agreement can be developed with the State. Since this is a primary access point for boaters, especially hunters and anglers, the installation of a Visitor Contact Station would increase visitor awareness and thus could decrease disturbances from these recreational activities to TES using the delta.

Effects to various TES from activities associated with the recreational trail system would be similar as described in Alternative A. See Sections 4.4.1.2, 4.4.2.2, and 4.3.2 for a description of effects to bald eagles, seabirds, and marine mammals. High public access of the trail adjacent to the restored estuarine areas along McAllister Creek could have negative effects on shorebirds on the BCC list, but disturbance would be localized to the vicinity of the trail (see Section 4.4.1.2). In addition, since the EE program would be increased to serve up to 20,000 students, disturbances to wildlife using habitats adjacent to the trail system could increase. This includes a number of birds that use riparian habitats such as rufous hummingbird and olive-sided flycatcher, both on the BCC list (USFWS 2001). However, effects would be localized to trails and study sites. As described above, Refuge outreach programs would emphasize responsible behavior, which can reduce disturbance.

Waterfowl hunting would be limited to WDFW lands. The removal of unauthorized hunting on Refuge lands would benefit estuarine-dependent TES, as well as BCC shorebird species that could also be disturbed by the activity (see Sections 4.4.1.2 and 4.4.2.2). Under all action alternatives, the RNA would be posted, and a no consumptive use policy would be enforced. This, along with winter boat closures, would provide increased sanctuary to TES species. Additionally, the closure of shellfishing in the RNA would benefit shellfish populations, which could contribute to shorebird prey availability. Decreased disturbance to these species in the estuary could also benefit bald eagles and peregrine falcons. The restriction of public access into the restored estuarine habitat under Alternative B (and C and D) would also benefit all TES that use this habitat.

Continued bank fishing along McAllister Creek, allowed under Alternatives B and C, could cause disturbance to eagles, including nesting birds. Boating restrictions under all action alternatives are expected to have positive effects on TES that use the estuary, Nisqually River, and McAllister Creek.

4.4.6.3 Alternative C

Habitat Restoration

The effects of restoration actions from Alternative C would be similar but greater than described in Alternative B. The restoration of full tidal conditions in the intertidal and river delta habitats would benefit marbled murrelets, bald eagles, brown pelicans, Steller sea lions, and shorebirds on the BCC list to varying degrees through improvements in forage abundance and diversity. See Sections 4.4.1.2, 4.4.2.2, and 4.3.2 for a description of effects to bald eagles, seabirds, fish, and marine mammals.

Effects from intensive management of the remaining freshwater wetland areas under this alternative would be similar to Alternative B, improving habitat quality and benefitting shorebird and landbird species identified on the BCC list (see Section 4.4.6.2). The additional 38 acres of riparian restoration would also benefit BCC-listed landbird species.

Refuge Expansion

Effects from Refuge expansion under Alternative C would be the same as described under Alternative B.

Public Use Program

Effects from the public use program in Alternative C would be similar to Alternative B. However, there would be no seasonal closure of the boardwalk extension during hunting season, resulting in some localized disturbance in that area during the winter months. The consolidated hunting area would reduce disturbance to bald eagles, great blue heron, and BCC-listed shorebird species in McAllister Creek. The 3 day/week hunting restriction would reduce the frequency of disturbance to some TES species. In contrast, the change in the western boundary of the RNA would remove some sanctuary areas at the mouth of the river for TES and BCC-listed shorebirds that frequent estuarine habitats.

4.4.6.4 Alternative D (Preferred Alternative)

Habitat Restoration

Alternative D would provide the largest area of estuarine restoration (699 acres), resulting in the greatest benefit to TES dependent on estuarine habitat, including bald eagle and marbled murrelets. Improved quality and quantity of estuarine habitat would also benefit the great blue heron and BCC-listed shorebirds. The potential short-term adverse effects associated with dike construction activities would be greater in this alternative, compared to Alternatives B and C, because of the higher amount of dike removal. Effects from improved freshwater wetland management and riparian restoration are similar to those described in Alternative C. See Sections 4.4.1.2, 4.4.2.2, and 4.3.2 for descriptions of effects to bald eagle, seabirds, shorebirds, fish, and marine mammals. Alternative D is the alternative that would best allow the Refuge to meet its goals.

Refuge Expansion

The proposed expansion area in Alternative D would provide the largest potential for increased habitat protection, the result of improving overall Refuge habitat quantity and quality, which would benefit TES species. Effects would be similar to those described in Alternatives B and C. The increase in watershed protection provided through acquisition and partnership building would increase water and tideland habitat quality, benefitting TES dependent on estuarine habitat. In addition, the slightly increased protection and restoration of the Nisqually River riparian corridor would benefit eagles and BCC-listed landbird species through improved riparian habitat and increased foraging opportunities (see Section 4.4.6.3).

Public Use Program

Effects to TES from the public use program would be similar to those described in Alternative C. Trail effects would be the least in this alternative because of the decreased trail length. Effects from activities associated with hunting would be similar to Alternative B, with the exception of opening 73 acres of the RNA to hunting. This would reduce the amount of sanctuary in the delta. However, by adding 44 acres to the RNA along the south end, the net loss of sanctuary would be reduced. Fishing effects on bald eagles would be reduced with the removal of bank fishing in the McAllister Creek.

4.4.7 Effects to State-Listed Species

Effects to the Washington State endangered western pond turtle and Oregon spotted frog are discussed in more detail in Section 4.4.3, Effects to Reptiles and Amphibians. These are the only Washington State-listed species with potential habitat in the study area. Effects to Washington State candidates species (Townsend's big-eared bat, common loon, merlin, pileated woodpecker, Lewis' woodpecker, and purple martin) are discussed in Effects to Birds or Mammals (Sections 4.4.1 and 4.4.2).

4.5 Effects to Special Uses

4.5.1 Alternative A

4.5.1.1 Habitat Restoration

Effects to Haying

Under this status quo alternative, no significant changes to the haying program are anticipated. The approximately 250 acres of Refuge grasslands would continue to be hayed under a Special Use Permit by a local farmer each year. In lieu of cash payment, a cooperative management agreement may be developed, and the cooperator would agree to provide services or materials to enhance the habitat in exchange for the hay removed, directly benefitting Refuge habitat. Haying operations would be conducted under current conditions (see Chapter 3).

Effects to Scientific Research

No significant changes would be expected to Refuge research opportunities. Researchers would be required to submit study proposals; once approved, projects would be conducted under Special Use Permits with special conditions identified to minimize effects on wildlife and habitat.

4.5.1.2 Refuge Expansion

Effects to Haying and Scientific Research

No effects would be expected since this alternative does not include acquisition of properties outside of the currently approved Refuge boundary.

4.5.1.3 Public Use Program

Effects to Haying and Scientific Research

Special conditions (zoning and timing) on research projects would continue to occur, as necessary, to avoid conflicts between public uses and research projects. No effects from the public use program on haying are anticipated.

4.5.2 Alternative B

4.5.2.1 Habitat Restoration

Effects to Haying

As a result of estuarine restoration and freshwater enhancement activities, the haying program would be reduced as the proportion of freshwater wetlands within the remaining diked area increases. In this alternative, a small amount of currently hayed grasslands, approximately 5

acres, would be restored to estuarine habitat. In addition, remaining grassland areas would be managed differently to enhance freshwater wetland habitats, reducing the total amount of grasslands that would remain for haying. All other aspects of the haying program would be the same as Alternative A.

Effects to Scientific Research

Effects would be the same as Alternative A, except that there would be an increased opportunity for researchers to study and compare muted and full estuarine restoration processes.

4.5.2.2 Refuge Expansion

Effects to Haying and Scientific Research

Acquisition of property within the expansion area may contain lands that could be included in the haying program. In addition, Refuge expansion would also increase the opportunities for research in the Nisqually delta because of increased accessibility.

4.5.2.3 Public Use Program

Effects to Haying and Scientific Research

Effects would be the same as Alternative A. Additional special conditions may be considered when evaluating research proposals because of changes in trail configurations.

4.5.3 Alternative C

4.5.3.1 Habitat Restoration

Effects to Haying

Effects would be the same as Alternative B, except the acreage of currently hayed grasslands lost to estuarine restoration would be higher under Alternative C, approximately 69 acres. In addition, the grassland acreage within the dike would be reduced to a much larger degree, reducing the haying program.

Effects to Scientific Research

Effects would be the same as Alternative B, except that the new opportunities for research would focus on a larger amount of estuarine restoration.

4.5.3.2 Refuge Expansion

Effects to Haying and Scientific Research

Same as Alternative B.

4.5.3.3 Public Use Program

Effects to Haying and Scientific Research

Same as Alternative B.

4.5.4 Alternative D (Preferred Alternative)

4.5.4.1 Habitat Restoration

Effects to Haying

As a result of estuarine restoration and freshwater enhancement activities, the haying program would be greatly reduced. Once major restoration activities are completed, less than 100 acres of grasslands would be managed on the Refuge, interspersed among permanent and seasonal freshwater wetlands. Once restoration is complete, haying on this reduced acreage may not be cost effective for a cooperator. If this is the case, the management of the remaining grasslands would become part of routine Refuge habitat management activities.

Effects to Scientific Research

Effects would be the same as Alternative B, except that research opportunities would include studying a larger estuarine restoration area (699 acres).

4.5.4.2 Refuge Expansion

Effects to Haying and Scientific Research

Effects would be the same as Alternatives B and C, except that the proposed acquisition includes more land; therefore, new opportunities for haying and research are greater.

4.5.4.3 Public Use Program

Effects to Haying and Scientific Research

Effects would be the same as Alternative B, except that more measures may need to be included in research permits to avoid conflicts with public use.

4.5.5 Effects to Tribal Fishing

The fishing rights of the Nisqually Indian Tribe and its members are provided for by the Medicine Creek Treaty Act of 1854. The Nisqually Indian Tribe directly manages and enforces activities associated with their commercial fisheries. Tribal fishing activities would continue under all alternatives.

4.6 Effects to Public Access, Education, and Recreational Opportunities

4.6.1 Alternative A

4.6.1.1 Habitat Restoration

Effects to Environmental Education, Wildlife Observation, Interpretation, Wildlife Photography, Waterfowl Hunting, Fishing and Shellfishing, and Boating

This alternative calls for continued management efforts, including the retention of 1,000 acres of freshwater wetlands and grasslands within the Brown Farm Dike, limited enhancement of these freshwater habitats, and some control of reed canary grass. Although there would be no change in public access, these management efforts would likely have a minor positive effect on recreational opportunities at the Nisqually NWR by improving wildlife viewing, interpretation, and photography associated with the wildlife species that prefer this habitat. However, these changes would deteriorate over time as reed canary grass continues to spread due to management limitations. Major dike repairs would have a short-term negative effect on trail access and wildlife viewing opportunities.

4.6.1.2 Refuge Expansion

Effects to Environmental Education, Wildlife Observation, Interpretation, Wildlife Photography, Waterfowl Hunting, Fishing and Shellfishing, and Boating

Other than the completion of the Refuge within the existing approved boundary, no Refuge expansion is proposed in this alternative. Nevertheless, acquiring or protecting lands within the existing boundary would likely have a positive indirect effect on recreational opportunities due to the improved management and habitat conditions anticipated on some of the acquired/protected lands, thus affording the public increased or improved wildlife-dependent recreational opportunities.

4.6.1.3 Public Use Program

Although most of the current features of recreation and public use at Nisqually NWR would remain unchanged under this alternative, there are several actions proposed in this alternative that would have an effect on public access, education, and recreational opportunities available at Nisqually NWR. These effects are discussed below.

Effects to Environmental Education

Under Alternative A, the Service would continue to provide a limited EE program, serving up to 5,000 students per year. The program is typically completely booked in the busy spring period. The increased demand for outdoor environmental education and a growing population base in the vicinity of Nisqually NWR would leave this high priority need unmet, and the program

quality would also not be improved as in all action alternatives. Although the program would continue to provide benefits, it would remain inadequate for serving the needs of the region for the type of environmental education offered at the Refuge, and Refuge goals would not be fully met.

One action common to all alternatives would be the construction of a new Environmental Education Center. The EE program was temporarily moved to a trailer near the maintenance compound after the Twin Barns Education Center was severely damaged by the February 2001 Nisqually Earthquake. A new and upgraded facility would ensure a safe, quality experience for school children participating in the Refuge's environmental program, and would therefore greatly benefit this program and its participating students.

The seasonal closure of a portion of the trail during the waterfowl hunting season would continue to affect some EE groups that would otherwise be interested in using the trail to observe salt marsh habitats. Continued unrestricted use of PWC and associated noise and disturbance to wildlife would continue to disturb EE groups and other trail users.

Effects to Wildlife Observation, Interpretation, and Wildlife Photography

Under Alternative A, the Refuge would continue to provide 7 miles of trails (primarily using the existing dike system), including an accessible and interpreted 1-mile loop boardwalk trail. This long-established and extremely well-used trail system is highly valued by many Refuge visitors. Many commentors during scoping for this CCP/EIS and subsequent public involvement efforts indicated their desire to keep the dike trail network in place. Therefore, retaining this length and type of trail system would continue to benefit public access and the recreational opportunities at Nisqually NWR. However, quality of the trail experience would not improve significantly since habitat improvements and increased wildlife use would be limited. The existing hunting would require that portions of the 5½-mile loop trail continue to be seasonally closed during the waterfowl hunting season to ensure visitor safety and provide wildlife sanctuary. This is the largest conflict among users in the delta, and most of the public comments received during scoping for this CCP/EIS stated that they preferred that the loop trail not be seasonally closed. Therefore, it is anticipated that the experience of many trail users would continue to be negatively affected by continued seasonal closures of the dike trail. Trespass problems on the trail by trail users unhappy with the closure would continue.

In addition to the continuation of the existing trail system, under Alternative A (and an action common to all of the alternatives), an unimproved, primitive ½-mile trail would be developed in the Nisqually River surge plain forest, connected to the existing boardwalk spur. This trail would be minimally maintained and would not provide full access for people with disabilities. Provision of this additional trail would have a positive effect on public access and recreational opportunities by providing more of an exposure to the surge plain habitat than currently exists. However, since this would be a primitive trail, access would be limited, especially during wetter periods of the year.

The Visitor Center would continue to be provided, including interpretive displays focusing on existing habitats and wildlife, thus providing a quality interpretive experience for many visitors. Interpretive panels would also continue to be provided along the 1-mile boardwalk loop.

Two existing photoblinds along the Brown Farm Dike Trail would continue to be maintained and upgraded as resources allow.

Effects to Waterfowl Hunting

Under Alternative A, the Refuge would continue to be closed to waterfowl hunting. However, the current unauthorized hunting on Refuge lands would continue. Thus, the current pattern of hunting activities would continue to result in insufficient sanctuary for waterfowl. Under Alternative A, unsigned areas would continue to be administratively uncontrollable, and closures in these areas would not be enforced.

Continuation of the current hunting activities under this alternative would result in more hunting access than any other alternative, although confusion over boundaries would continue. Many waterfowl hunters commented on the confusion and requested that jurisdiction and boundary problems be resolved and made consistent. Almost no comments were received supporting retaining the current situation. There would be no increase in public outreach or education for the hunting program by the Refuge.

Effects to Fishing and Shellfishing

Under this alternative, the Service would continue to allow fishing by boat. All State regulations would apply. The Refuge would maintain the McAllister Creek Bank Fishing Area, and allow fishing in this area by foot or boat. However, seasonal closures on the northern portion of this bank fishing area would still occur during the waterfowl hunting season. Fishing opportunity is expected to decrease in response to the closure of the McAllister Creek Hatchery (July 2002). Closures of the RNA to consumptive uses, including fishing and shellfishing, would not be enforced. The allowance of fishing on the Refuge would continue to benefit public fishing opportunities available at Nisqually NWR, especially by continuing provision of bank fishing on McAllister Creek. There are no other public access locations via foot traffic on McAllister Creek outside of the Refuge, although fishing opportunity is expected to decrease with the closure of the McAllister Fish Hatchery (July 2002). Because no new fishing opportunities would be created under this alternative, fishing activities on the Refuge would not be improved, thus resulting in lost or fewer opportunities for quality fishing.

Under this and all other alternatives, recreational shellfishing would continue to be allowed outside the Brown Farm Dike according to County and State regulations. However, shellfishing would remain closed in the tideflats as currently directed by the Washington State Department of Health. These shellfish beds may re-open for recreational harvest after fecal coliform bacteria levels reach approved levels. Additionally, recreational and commercial geoduck harvest would continue under State regulation in waters in or adjacent to the Refuge. The allowance of recreational shellfishing and geoduck harvest on the Refuge would provide a continued benefit for shellfishing opportunities available at Nisqually NWR.

Effects to Boating and Personal Watercraft (PWC)

Under this alternative, motorized and non-motorized recreational boating would continue to be allowed in all waters of the Refuge outside of the Brown Farm Dike. Thurston County

regulations would apply, requiring a speed limit for all watercraft of 5 mph within 200 feet of any shoreline. However, because of limited staff and funding, this regulation would not be enforced by the Service. The allowance of the various boating activities would have a continued benefit on boating opportunities in south Puget Sound.

PWC use on the Refuge would also continue. However, continued use of PWC within the Refuge would result in continued conflicts (e.g., noise, wildlife disturbance, safety) between PWC users and other Refuge visitors (e.g., canoers, kayakers, anglers, motorized boaters, trail users, and wildlife observers) causing a negative effect on these recreationists. In addition, there would continue to be a lack of Refuge information readily available to most boaters due to the absence of a contact station at Luhr Beach.

Effects to Other Non-Wildlife Dependent Recreational Activities

Under this and all other alternatives, the collection of apples and blackberries for off-site consumption would no longer be allowed. Picking would be restricted to trails only and for consumption only while on the Refuge. Additionally, to protect sensitive wildlife habitat and maintain established wildlife sanctuary areas closed to public entry, other plant material and mushroom picking would continue to be prohibited. This limit on fruit collecting would benefit those participating in wildlife observation by reducing off-trail wildlife disturbance. Prohibiting and/or reducing fruit and plant collection would have a negative effect on those persons participating in these activities. However, due to the availability of numerous and similar opportunities in the vicinity of Nisqually NWR and elsewhere, this would be expected to result in a only a minor negative effect to these recreationists.

4.6.2 Alternative B

4.6.2.1 Habitat Restoration

Effects to Environmental Education, Waterfowl Hunting, Fishing and Shellfishing, and Boating

Under Alternative B, 318 acres of muted and 140 acres of full estuarine habitat would be restored, which would reduce the total amount of freshwater habitat on the Refuge. However, improved management of freshwater habitat would improve habitat quality within the diked area, although not as effectively as in Alternative D. Improved habitat quality for both estuarine and freshwater habitats would improve wildlife use of these areas (see Effects to Wildlife, Section 4.4). However, since this alternative contains the smallest degree of estuarine restoration and freshwater management improvements, it would result in the smallest improvement of wildlife use in both the estuarine and freshwater habitats. These limited improvements would still enhance environmental education opportunities, particularly the opportunity to observe active habitat restoration/management activities. In addition, enhanced waterfowl habitats may encourage more waterfowl to use the delta, improving waterfowl hunting opportunities. A similar effect would be expected on fish populations inhabiting estuarine habitat, with some long-term benefits for fishing opportunities in the delta, Nisqually River, and McAllister Creek.

Effects to Wildlife Observation, Interpretation, and Wildlife Photography

Overall, it is anticipated that the habitat restoration activities would have a positive effect on wildlife observation, interpretation, and photography opportunities at the Refuge by making limited improvements to habitat quality (see above), potentially increasing the number and diversity of associated wildlife species. The trail experience would be diversified, in that sections of the trail would be surrounded on both sides by estuarine habitat (muted on one side), giving visitors a chance to be within the estuarine habitat instead of just along the edge. Although there is some change in trail configuration because of estuarine restoration in Alternative B, the trail would remain relatively the same as Alternative A. Therefore, this is the only action alternative that would provide some estuarine restoration and improved freshwater habitat quality with very little change to trail length and configuration.

4.6.2.2 Refuge Expansion

Effects to Environmental Education, Wildlife Observation, Interpretation, and Wildlife Photography, Waterfowl Hunting, Fishing and Shellfishing, and Boating

This alternative would continue efforts to acquire interests in the remaining 1,011 acres of State and privately owned lands within the existing approved boundary, including pursuit of a cooperative management agreement with the State to allow the Service to manage the Luhr Beach boat landing area. Effects from this action would be the same as described in Alternative A, but would also include an expanded EE program in partnership with the Nisqually Reach Nature Center. In addition, a new visitor contact station at Luhr Beach would improve opportunities for wildlife interpretation and provide helpful regulatory information for boaters, hunters, and anglers that launch at this location.

Alternative B would also provide for expansion of the Refuge boundary (2,407 acres), including upland habitat along the East Bluff and McAllister Creek, as well as floodplain, riparian, and wetland habitat within portions of the Nisqually Valley floodplain, creeks, and sloughs. This expansion area would include a Service-managed fishing opportunity in the Trotter's Woods area. Refuge management of this site would improve the quality of fishing experience by providing law enforcement and improved facilities. In addition, an accessible fishing site would be explored at Luhr Beach. New opportunities for quality wildlife observation (trails), hunting, and fishing would potentially be created if sufficient and appropriate areas are acquired that would also provide adequate wildlife sanctuary. East Bluff trails would potentially link to other trails in the area, providing additional recreational benefits.

4.6.2.3 Public Use Program

Effects to Environmental Education

Construction of a new Environmental Education Center with upgraded facilities would have a beneficial effect on this educational opportunity at Nisqually NWR.

The EE program would be improved and expanded to serve up to 20,000 students (compared to 5,000 under Alternative A). Additional materials and curricula would be developed, teacher training and field trip support provided, staff support increased, and partnerships strengthened, including with the Nisqually Reach Nature Center. This partnership would provide an even stronger program to educate the public on the marine resources of the Nisqually delta and disseminate a consistent theme and message related to environmental education on the Refuge.

Program improvements, increased capacity, and staff support would increase the quality of the program, providing a model for other environmental programs in the Puget Sound area. This alternative would greatly strengthen and maximize the EE program on the Refuge, resulting in a significant positive effect on the environmental opportunities available in south Puget Sound.

Effects to Wildlife Observation, Interpretation, and Wildlife Photography

Effects would be similar to Alternative A, since the majority of the trail would remain unchanged. As noted under Alternative A, this trail system is highly valued by numerous Refuge visitors, many of whom have stated their preference for leaving the dike loop trail intact. Therefore, since only minor modifications would be made to the configuration of the loop trail, and the overall trail length would remain the same, this alternative would provide a continued benefit for wildlife observation, interpretation, and photography opportunities available at Nisqually NWR. However, a portion of the trail would still need to be seasonally closed during the waterfowl hunting season, negatively affecting trail users (see Section 4.7.1).

Effects from facilities would also continue be the same as described in Alternative A, except for the additional Visitor Contact Station at Luhr Beach. This new Visitor Contact Station would improve opportunities for wildlife interpretation of Refuge resources. Effects from the new trail in the surge plain would be the same as described under Alternative A.

Effects to Waterfowl Hunting

Under Alternative B, a waterfowl hunting program would not be implemented on the Refuge, and the Refuge boundary would be clearly signed to delineate it from WDFW property where hunting would continue to be allowed. WDFW would continue to have jurisdiction and management responsibility over WDFW lands. However, the Service (through increased staffing) would actively enforce the no hunting regulations, eliminating the previous unauthorized hunting that has occurred in unsigned portions of the Refuge.

Continued use of the WDFW property for waterfowl hunting would continue to provide hunting opportunities in the Puget Sound area. Eliminating unauthorized hunting on the Refuge would end the current situation which provides insufficient wildlife sanctuary and would meet the majority of the (commenting) public's desire that hunting be discontinued. However, by enforcing the closure on the Refuge it would also mean eliminating a portion of the area currently available to hunters resulting in a negative effect on hunting opportunities in the delta. This would reduce confusion for hunters and clarify legal hunting areas. Posting and restricting hunting to State lands would also clarify boundaries for other boaters, reducing conflicts with hunters, including kayakers who could then easily avoid hunting areas. Boat speed restrictions

would positively affect hunters by reducing waterfowl disturbance and noise in the hunting area. At the same time, speed restrictions would increase travel time slightly for hunters when traveling to and from the hunting areas.

Effects to Fishing and Shellfishing

Effects would be the same as Alternative A. Under Alternative B, the Trotter's Woods area south of I-5, if acquired or under a cooperative management agreement, would be managed to provide a quality bank fishing area along the Nisqually River. Also proposed is an accessible fishing site at Luhr Beach. These new or improved fishing areas would positively affect fishing opportunities in the area. In contrast, the closure of the RNA to fishing, as well as other consumptive uses, would negatively affect fishing opportunities on the Refuge. Boat speed restrictions would positively affect anglers by reducing disturbance, noise, and wakes in the fishing areas. However, speed restrictions would increase travel time for anglers traveling through the area. A portion of the McAllister Creek bank fishing area would continue to be seasonally closed due to waterfowl hunting on adjacent State lands. Fishing opportunity is expected to decrease along McAllister Creek, in response to the closure of the McAllister Creek Hatchery (July 2002).

Shellfishing opportunities and the subsequent effects would be the same as described under Alternative A. A Visitor Contact Station at Luhr Beach would alert shellfishermen to current restrictions, helping to ensure safety and a quality experience.

Effects to Boating and Personal Watercraft (PWC)

Under Alternative B, and all other action alternatives, a boat speed limit of 5 mph would be established in all Refuge waters. Additionally, under Alternative B (and all other action alternatives), all restored areas, as well the RNA from October 1 to March 31, would be closed to boating to provide additional sanctuary for migratory birds and other wildlife. These actions would have a negative effect on boating within the Refuge, particularly motorized watercraft. However, it is anticipated that the effects would be minor due to the continuance of boating in the Refuge (albeit at lower speeds) and because of the availability of numerous and similar water bodies in proximity to Nisqually NWR. In addition, 5 mph boat speed restrictions already exist within 200 feet of any shoreline by Thurston County regulation. It would be expected that boat speed restrictions would largely preclude PWC use in Refuge waters. However, due to the availability of numerous and similar water bodies in proximity to Nisqually NWR, this would not be expected to result in a significant negative effect. Speed restrictions would improve safety and the quality of wildlife viewing for nonmotorized boaters, including kayakers and canoeists.

Effects to Other Non-Wildlife Dependent Recreational Activities

Other non-wildlife dependent opportunities (berry and apple picking, plant material and mushroom harvest) and the subsequent effects would be the same as described under Alternative A.

4.6.3 Alternative C

4.6.3.1 Habitat Restoration

Effects to Environmental Education, Wildlife Observation, Interpretation, Wildlife Photography, Waterfowl Hunting, Fishing and Shellfishing, and Boating

Under Alternative C, 50% of the diked interior would be restored to estuarine habitat through dike removal, and 38 acres of riparian habitat would be restored along the Nisqually River. The total amount of freshwater habitat would be reduced on the Refuge, more than in Alternative B. However, improved habitat quality of estuarine, riparian, and freshwater habitats would improve wildlife use of these areas (see Section 4.4). These improvements would also enhance environmental education opportunities, particularly the opportunity to observe and learn about active habitat restoration/management activities and estuaries. In addition, enhanced waterfowl and fish habitats would be expected to support more waterfowl and fish in the delta, improving viewing opportunities for school groups. Waterfowl hunting and fishing opportunities would also be enhanced due to increased waterfowl and fish use in the delta.

Habitat restoration activities would have a positive effect on wildlife observation, interpretation, and photography opportunities at the Refuge by improving habitat quality (see above), potentially increasing numbers and diversity of associated wildlife species. However, the current 5½-mile loop trail would be reduced to a 3¾-mile loop trail including a boardwalk spur into the estuary. This reduction of the 5½-mile loop trail would have a negative effect on trail use at the Refuge by eliminating the unique experience provided by a loop trail of this length in south Puget Sound. However, quality of the experience would be improved by increased wildlife viewing opportunities and improved access to estuarine habitats. The boardwalk spur would allow visitors to be within the estuary, instead of along the edge.

4.6.3.2 Refuge Expansion

Effects to Environmental Education, Wildlife Observation, Interpretation, Wildlife Photography, Waterfowl Hunting, Fishing and Shellfishing, and Boating

Effects from proposed Refuge expansion under this alternative would be the same as described for Alternative B.

4.6.3.3 Public Use Program

Effects to Environmental Education

Construction of a new Environmental Education Center with upgraded facilities would have a beneficial effect on this educational opportunity at Nisqually NWR.

The EE program under this alternative would be the same as Alternative B, except that the program would serve up to 15,000 students each year (instead of 20,000). As in Alternative B, a partnership with the Nisqually Reach Nature Center would provide a stronger program to

educate the public on marine resources of the Nisqually delta and disseminate a consistent theme and message related to environmental education on the Refuge.

As in Alternative B, program improvements would increase the quality of the program, providing a model for other environmental programs in the Puget Sound area, resulting in a significant positive effect on the environmental opportunities available in south Puget Sound. However, this alternative would not serve as many students as Alternative B because the Service-managed hunting program would divert staff time that could otherwise be used for a larger EE program. The significantly increased law enforcement, sign maintenance, administration, and public outreach associated with the hunting program would result in an EE program below maximum potential.

Effects to Wildlife Observation, Interpretation, and Wildlife Photography

Dike removal associated with estuarine restoration would reduce the current 5½-mile loop trail to a 3¾-mile loop trail including a boardwalk spur along McAllister Creek. As noted under Alternative A, the dike trail is highly valued by numerous Refuge visitors, many of whom stated their preference for leaving the dike trail intact. Therefore, since approximately 30% of the trail length would be lost, this alternative would negatively affect trail users by eliminating the unique experience provided by a loop trail of this length. At the same time, the majority of comments received stated that fish, wildlife, and habitat needs should take priority in making trail decisions. The effect to trail length is not expected to significantly reduce wildlife observation opportunities or access to all habitat types because improved habitat management would result in higher habitat quality and wildlife use. Trails would be expected to provide equal, if not improved, wildlife observation, interpretation, and photography opportunities currently available at Nisqually NWR. Many respondents also expressed a strong desire for trail access to all habitat types, even if trail length was reduced. The reconfigured dike trail loop and new trails (see below) in this alternative would provide access to estuarine, riparian, freshwater, and grassland habitats. This trail would also allow visitors that were not physically able to hike the length of the 5½-mile loop to see the estuary and Puget Sound within a shorter distance, thereby making this experience available to a wider group of the public. The shorter trail may potentially create a crowding problem, particularly on busy weekends in the spring and summer. However, this problem could be alleviated by the new trail east of the Nisqually River (see below). The hunting program proposed in this alternative would not require seasonal closure of the main dike trail, including the new boardwalk extension. This would be very beneficial to trail users as this is a current conflict (see discussion in Alternatives A and B). Effects from the new trail in the surge plain would be the same as described under Alternative A.

A new 2½-mile loop trail on tribal and Refuge property east of the Nisqually River would provide new wildlife observation opportunities and compensate for the loss of part of the main dike trail. This trail would take visitors through seasonally flooded pastures, the Nisqually River, Red Salmon Creek, and associated salt marshes, providing a loop trail within the estuary. This is a wildlife observation experience that has never been available on the Refuge. This trail would be seasonally closed during the waterfowl hunting season until the private hunt club ceases operation. In the future, this trail could be opened year-round, providing good wildlife viewing when winter migratory birds are present. If lands are acquired on the East Bluff, as proposed in this alternative, another new trail option would be possible, linking with planned Pierce County trails.

Effects from facilities would be the same as those described under Alternative B, except for an additional Visitor Contact Station, trail and boardwalk, signs, and parking area associated with the proposed 2½-mile loop trail on tribal and Refuge property east of the Nisqually River. Development of these facilities would be necessary to open this east side trail, and would directly benefit visitors observing wildlife and students participating in environmental education.

Effects to Waterfowl Hunting

In Alternative C, the Service would manage a quality hunting program on 1,170 acres of Refuge and WDFW lands. Provisions for this program would include: 3 day/week hunting, 25-shell limit, and no restriction on the number of hunters. Management of the hunting program by the Service would increase outreach, education, and enforcement efforts, which would improve the quality of the program for hunters. Reducing the number of hunting days per week would reduce hunting opportunity but would increase quality. No hunting days would encourage more birds to return to the hunting area, improving harvest opportunities on hunting days. Birds would benefit by being able to make more use of hunted areas for feeding and resting. The 25-shell limit would also contribute to increased hunt quality, reducing wildlife crippling and disturbance caused by out-of-range shooting. Consolidating the hunting area into a single rectangular block north of the Brown Farm Dike at Nisqually would reduce confusing boundary issues and consolidate hunting activity in the delta, reducing disturbance in McAllister Creek, making the hunting area more manageable.

This hunting program would eliminate unauthorized hunting on the Refuge. This would be consistent with the Service's determination that waterfowl hunting as it currently occurs does not provide sufficient wildlife sanctuary. However, as described in Alternative B, enforcing this closure would negatively affect waterfowl hunting opportunities in the delta, primarily by closing McAllister Creek to hunting and eliminating unauthorized hunting. Hunting in McAllister Creek is considered a different experience than in the tideflats because it is more sheltered in stormy weather. The loss of 3 to 4 hunting sites in McAllister Creek would be offset by officially opening the Refuge lands north of the dike and at the mouth of the Nisqually River. These new areas are heavily used by waterfowl and would provide desirable hunting locations. Boat speed restrictions would positively affect hunters by reducing waterfowl disturbance and noise in the hunting area. However, travel time would be increased somewhat for hunters going to and from the hunting area.

Effects to Fishing and Shellfishing

Fishing opportunities provided under Alternative C would be the same as described in Alternative B, except under Alternative C an additional fishing area would be provided off a new loop trail east of the Nisqually River north of I-5 on tribal and Refuge lands. However, this access would be seasonally closed during the waterfowl hunting season, until the private hunt club ceases operation.

The continuation of and additional fishing opportunities afforded under this alternative would have a positive effect on fishing opportunities on the Refuge by expanding the area available for bank fishing on the Nisqually River. A positive effect, occurring in this alternative only, is the

ability to keep the entire McAllister Creek bank fishing area open during the hunting season. This is possible because the hunting area would be located north of the fishing area.

Shellfishing opportunities and the subsequent effects would be the same as described under Alternative A.

Effects to Boating and Personal Watercraft (PWC)

Boating opportunities and PWC use and the subsequent effects would be the same as described under Alternative B.

Effects to Other Non-Wildlife Dependent Recreational Activities

Other non-wildlife dependent opportunities (berry and apple picking, plant material and mushroom harvest) and the subsequent effects would be the same as described under Alternative A.

4.6.4 Alternative D (Preferred Alternative)

4.6.4.1 Habitat Restoration

Effects to Environmental Education, Wildlife Observation, Interpretation, Wildlife Photography, Waterfowl Hunting, Fishing and Shellfishing, and Boating

Under this alternative, 70% of the diked interior would be restored to estuarine habitat through dike removal, creating 699 acres of this habitat type. This alternative also calls for new dikes to protect 263 acres of improved freshwater and riparian habitat. As in Alternative C, 38 acres of riparian habitat along the Nisqually River would be restored.

Estuarine restoration actions would reduce the total amount of freshwater habitat on the Refuge more than any other alternative. However, intensified management of this area, as well as riparian areas, would increase habitat quality and improve wildlife use (see Section 4.4). This would result in positive effects on wildlife observation, interpretation, and photography opportunities at the Refuge. Recent freshwater restoration projects in 2000 and 2001 in the headquarters area, with greatly increased and diversified bird use as a result, provide examples of the potential benefits for wildlife viewing. These improvements would also enhance environmental education opportunities, particularly the opportunity to observe active habitat restoration/management activities. In addition, enhanced waterfowl and fish habitats may encourage more waterfowl and fish to use the delta, improving waterfowl hunting and fishing opportunities.

Habitat restoration activities would negatively affect the Refuge trail system. The current 5½-mile loop trail would be reduced to a 3½-mile round-trip (no loop) trail, including a ½-mile boardwalk into the estuary. As described in Alternative C, eliminating a loop trail of this length would have a negative effect on trail users in south Puget Sound. However, it is anticipated that the opportunities to view wildlife and still experience diverse habitats on the remaining trails

would be retained and improved due to habitat improvements and greater accessibility to estuarine habitats (see above). In addition, new trails would be developed in expansion areas to provide new wildlife observation opportunities (see below).

4.6.4.2 Refuge Expansion

Effects to Environmental Education, Wildlife Observation, Interpretation, Wildlife Photography, Waterfowl Hunting, Fishing and Shellfishing, and Boating

The effects from acquiring interests in lands remaining within the approved boundary and from proposed expansion would be the same as described in Alternative B. However, proposed expansion in this alternative would add 1,011 acres along the Nisqually River corridor and 1,952 acres in the Nisqually Valley. Effects described under Alternative B would also apply here. In addition, this would provide the highest level of improved habitat conditions and future protection among all the alternatives. This increased protection would be expected to result in an indirect positive effect on recreational opportunities, such as fishing and hunting. In addition, bank fishing opportunities would be developed along McAllister Creek south of I-5, if appropriate sites were acquired. This would provide new bank fishing access to compensate for the loss of McAllister Creek bank fishing north of I-5, as a result of estuarine restoration. However, the closure of the McAllister Creek Hatchery in July 2002 is expected to reduce fishing opportunity along McAllister Creek.

4.6.4.3 Public Use Program

Effects to Environmental Education

Similar to all alternatives, construction of a new Environmental Education Center with upgraded facilities would have a beneficial effect at Nisqually NWR.

Effects to the EE program under this alternative would be similar to those described in Alternative C. The differences in effects in Alternative D include the seasonal closure of the boardwalk extension and the 7 day/week hunting program. As described in Alternative C, the expansion of environmental education in this alternative is lower than in Alternative B, due to the staffing and funding that would be directed toward the hunting program. However, since the hunting program in this alternative would cover approximately 55 to 60 more days (7 day/week instead of 3 day/week) than Alternative C, slightly more staff time and funds would be directed toward hunting and away from the EE program. The EE program, however, would still strive to serve 15,000 students. The seasonally closed boardwalk extension would limit the amount of trail that can be used to view or study estuarine habitats.

Effects to Wildlife Observation, Interpretation, and Wildlife Photography

Effects from proposed new trails in the surge plain, east of the Nisqually River, and on the East Bluff would be the same as for Alternative C. Dike removal associated with estuarine restoration would reduce the current 5½-mile loop trail to a 3½-mile round trip (non-loop) trail with a boardwalk extension along McAllister Creek. Effects from this trail change are similar to

those described in Alternative C; however, the reduction of trail length is the greatest (37% decrease in round trip length) among all of the alternatives. This represents the largest negative effect to trail users among all of the alternatives. In addition, the trail would no longer be a loop, a major effect for Refuge visitors that prefer a loop experience. The new loop trail east of the Nisqually River (as described in Alternative C) would provide new wildlife observation opportunities and help reduce the effects of the loss of a loop configuration, as well as length, on the main dike trail.

Despite effects to trail length and configuration, proposed changes to the trail in this alternative are not expected to significantly negatively affect wildlife observation. As explained in Alternative C, improved habitat management would result in higher habitat quality and wildlife use. In addition, the remaining trail would provide easier access to a variety of habitats for a larger sector of the public because of the shorter distance. The shorter trail, however, may create a crowding problem, especially on busy weekends in the spring and summer. Because the trail would no longer be a loop, crowding would be a greater potential problem in Alternative D. However, this problem could be alleviated in part by the new trail east of the Nisqually River and the potential trail on the East Bluff (see Alternative C for additional effects).

Because of hunting on WDFW lands in McAllister Creek, the boardwalk extension would be seasonally closed during the waterfowl hunting season. As described in Alternatives A and B, most of the public comments received stated that they preferred that the trail not be seasonally closed. Therefore, it is anticipated that the experience of most trail users would continue to be negatively affected by the continuation of seasonal closures of the dike trail. This negative effect is increased by the reduction in overall trail length in Alternative D, reducing the amount of trail area available during the hunting season as compared to other alternatives. Effects from facilities would be the same as described in Alternative C.

Effects to Waterfowl Hunting

Under this alternative, the Refuge would officially open 191 acres to a 7 day/week waterfowl hunting program. These lands would be adjacent to the WDFW lands north of the Brown Farm Dike, creating a block of land and eliminating confusing boundary issues in this area. The RNA would be reduced to allow for an area at the mouth of the Nisqually River to be opened to hunting.

The opening of Refuge lands to hunting would have a positive effect on waterfowl hunting opportunities in south Puget Sound, similar to the effects described under Alternative C. Although there would be a negative effect caused by eliminating unauthorized hunting on other parts of the Refuge, there would still be hunting available on WDFW lands in McAllister Creek, and waterfowl hunting would continue to occur on a 7 day/week schedule.

Effects to Fishing and Shellfishing

Fishing opportunities would be the same under this alternative as described in Alternative C, except that the bank fishing area along McAllister Creek would no longer be available. However, in addition to the two proposed bank fishing locations on the Nisqually River, the Refuge would investigate an additional accessible bank fishing area at the Nisqually River Overlook off the Twin Barns Loop Boardwalk Trail. However, a stationary fishing platform

may not offer a constant opportunity if river dynamics change, as has happened in other locations. Thus, design of this accessible site would need to ensure long-term use. The loss of the McAllister Creek bank fishing area would be a large effect to anglers in the area because there is no other public bank fishing access on McAllister Creek, although some limited bank fishing does occur south of I-5 on private property. However, WDFW closed the McAllister Creek Hatchery (July 2002). The fishing opportunities in McAllister Creek would consequently decline and thus, loss of the bank fishing area would be limited because fishing for fall chinook (the predominant angling opportunity) would decline dramatically. In either case, the Service would create a new public access south of I-5 along McAllister Creek if appropriate properties can be acquired. Overall, fishing opportunities at Nisqually NWR are not expected to decrease. The experience for anglers would shift from a focus on the McAllister Creek to the Nisqually River, which would mean a loss of fishing experience in slower flowing waters.

Shellfishing opportunities and the subsequent effects would be the same as described under Alternative A.

Effects to Boating and Personal Watercraft (PWC)

Boating and PWC opportunities and the subsequent effects would be the same as described under Alternative B.

Effects to Other Non-Wildlife Dependent Recreational Activities

Other non-wildlife dependent opportunities (berry and apple picking, plant material and mushroom harvest) and the subsequent effects would be the same as described under Alternative A.

4.7 Effects to Cultural Resources

Cultural resources have the potential to be directly affected by ground-disturbing activities such as facilities construction, dike repairs, or dike removal, as well as indirectly by activities that increase public access to sensitive cultural areas. Watercraft wakes and erosion threaten archaeological sites along the banks of McAllister Creek. Activities such as wildlife observation, interpretation, photography, and environmental education, when confined to non-sensitive cultural areas, can be perceived as having a neutral effect, in that they result in minimal to no effect on cultural resources; moreover, public programs that include interpretation of the cultural history of the Refuge provide an indirect educational benefit.

The management of cultural resource values of Nisqually NWR would comply with the regulations of Section 106 of the National Historic Preservation Act (NHPA). Therefore, determining whether a particular action within an alternative has the potential to affect cultural resources is an ongoing process that occurs within the planning stages of each project.

4.7.1 Alternative A

4.7.1.1 Habitat Restoration, Refuge Expansion, and Public Use Program

Under Alternative A, minor effects to cultural resources on the Refuge would be anticipated. The Brown Farm Dike has been determined eligible for listing on the NRHP; therefore, extensive dike repairs needed would be considered an undertaking with the potential to negatively affect the significant historical resource as per the NHPA. Mitigation for modification of the dike would entail, at a minimum, Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) documentation to National Park Service standards. Archaeological sites on the banks of McAllister Creek would continue to be eroded by natural tidal influence and watercraft wakes. Continued boating and waterfowl hunting throughout much of McAllister Creek may potentially expose these sites to more vandalism or damage. Interpretive benefits would continue to be provided under all alternatives in exhibits in the Visitor Center and panels along the 1-mile boardwalk loop that include information about cultural resources.

4.7.2 Alternative B

4.7.2.1 Habitat Restoration, Refuge Expansion, and Public Use Program

The dike breaching and extensive dike repairs proposed in Alternative B would have an effect on the dike, an NRHP-eligible historic property. The majority of the Brown Farm Dike would remain. Mitigation for modification or removal of the dike would entail, at a minimum, HABS/HAER documentation to National Park Service standards.

Federal acquisition would have a positive effect on those resources that are currently located on private land, by providing the protection afforded by the NHPA to resources located on Federal property. Depending on the areas acquired, expansion of the Refuge boundary, especially in the

East Bluff area, would bring several known archaeological sites under the jurisdiction of the Service, providing protection under the NHPA. The majority of the sites in the study area, however, are found on the Fort Lewis Military Reservation owned by the U.S. Army. Transferring them to Service ownership would have a neutral effect. Inventory for cultural resources within the expanded boundary prior to construction of public use facilities and habitat restoration projects would prevent damage to sites.

Expanding the EE program would offer an opportunity to include more of the cultural heritage of the Nisqually delta. The largest number of students would benefit from the EE program of all alternatives. Incorporating information about how the land has been used and changed by people would not only partially mitigate for modifications to cultural properties such as the dike, but would also improve public knowledge and appreciation of the resources. Environmental study site locations would be selected to avoid effects on sensitive sites. Boat speed restrictions would have a positive effect by reducing wake effects on sensitive sites. Enforcement of areas closed to waterfowl hunting, shellfishing, boating, and PWC would decrease negative effects to creek bank archaeological sites.

4.7.3 Alternative C

4.7.3.1 Habitat Restoration, Refuge Expansion, and Public Use Program

Effects to cultural resources under Alternative C would be similar to Alternative B except for the greater degree of dike removal, increasing effects on the dike; however, portions of the dike would remain. As in Alternative B, a cultural resource inventory would be conducted prior to the development of trails on the east side of the river as well as all public use facilities and habitat restoration projects within the expanded Refuge boundary, to identify and protect cultural resources potentially affected. A smaller number of students would benefit from the EE program, including cultural heritage topics, compared to Alternative B. All other effects would be the same as described in Alternative B.

4.7.4 Alternative D (Preferred Alternative)

4.7.4.1 Habitat Restoration, Refuge Expansion, and Public Use Program

This alternative would have the same effects as Alternative C, except for increased effects on the dike due to dike removal and the larger expansion area; however, portions of the dike would remain. The expansion area in the Nisqually River corridor may include cultural resources. Inventory for cultural resources within the expanded boundary would occur as described in Alternative B. The same number of students would benefit from the environmental education programs, including cultural heritage topics, as in Alternative C.

4.8 Effects to Socioeconomics

This section analyzes effects to the economy of the area in the general vicinity of the Nisqually River Valley associated with each of the alternatives. Effects to six topics are described: environmental justice, land use, Refuge management, economics on the regional economy, recreation economics, and commercial shellfishing.

4.8.1 Effects to Environmental Justice

This section analyzes potential disproportionately high and adverse human health or environmental effects of each of the CCP alternatives on minority populations and low-income populations living in the vicinity of the Nisqually River Valley. As discussed in Chapter 3, the population of the region does not meet HUD's definition of low income; however, the Nisqually Indian Tribe is one minority group that could be disproportionately affected. Specific effects to the Nisqually Indian Tribe are discussed below.

Under all alternatives, the Nisqually Indian Tribe would continue to fish, hunt, and gather as described in Article 3 of the Treaty of Medicine Creek of 1854 (10 Stat. 1132). A strengthened partnership between the Nisqually Indian Tribe and the Service is anticipated from the development of a Cooperative Agreement for the management of the tribe's 325-acre Braget parcel as part of the Refuge and due to mutual goals of protecting the watershed, river corridor, and fish habitats. There are no anticipated adverse health or environmental effects to the Nisqually Indian Tribe from any of the alternatives.

4.8.1.1 Alternative A

Under this alternative, tribal fishing, hunting, and gathering opportunities are expected to remain the same.

4.8.1.2 Alternatives B - D

Under the action alternatives, tribal fishing opportunities are expected to improve in the long-term due to estuarine restoration, which would improve fish habitat particularly for chinook and chum salmon and other estuarine-dependent fish species. Anticipated effects are minimum (Alternative B), moderate (Alternative C), and maximum (Alternative D) improvements to fisheries resources available for tribal fishing. Significant benefits would be expected, particularly from the effects of Alternative D, because tribal members depend heavily on natural resources, both culturally and economically (D. Troutt, pers. comm.). Refuge boundary expansion may affect the Nisqually Indian Tribally owned lands or trust lands, but protective methods would be restricted to cooperative agreement and lands would continue to be managed consistent with tribal priorities of protecting the watershed and river corridor. Some indirect benefits to the Nisqually Indian Tribe are also anticipated from Refuge visitors being better informed about Native American culture, which is an important component of the expanded EE program in each of these alternatives.

4.8.2 Effects to Land Use and Transportation Patterns

This section analyzes potential land use effects associated with each alternative. In addition to general land use and management, special status lands within the study area such as the Research Natural Area, Nisqually Public Use Natural Area, Shorelines of Statewide Significance, and National Recreation Trail are evaluated for consistency with policies and directives.

4.8.2.1 Alternative A

General Land Use, Transportation, and Management

No significant effects to land use and management are anticipated under this status quo alternative. No additional acreage would be added to the existing approved Refuge boundary, which would remain at 3,936 acres. Refuge acquisition of the remaining 1,011 acres within the existing boundary would continue as land and funding become available on a willing seller basis. Thurston and Pierce counties would continue to receive Refuge revenue payments in lieu of property taxes for Federal Refuge lands.

Housing developments would continue to increase under existing County regulations. In Pierce County, approximately 240 acres in single- and multi-family units would be developed along the top of the bluff, adjacent to the eastern boundary of the Refuge. Future zoning changes could occur as a result of area growth.

Under this alternative, it is expected that recreational fishing and agricultural use would continue along existing trends. Agricultural lands outside of the Thurston County's Purchase of Development Rights (PDR) program could be developed in the future as permitted under existing County regulations.

It is anticipated that Fort Lewis will continue to use the lower Nisqually River Valley as a buffer between civilian land in Thurston County and high impact military uses.

Transportation patterns would continue to evolve consistent with County plans and development proposals. No effects to transportation patterns are anticipated.

Special Status Lands

There are no anticipated effects to special status land designations under the No Action Alternative.

4.8.2.2 Alternative B

General Land Use, Transportation, and Management

Implementing Alternative B would result in approximately 2,407 acres in Thurston and Pierce counties being added to the existing approved Refuge boundary. This addition could include

approximately 512 acres of bluff habitat and 1,891 acres of floodplain, riparian, and wetland habitat.

This alternative would significantly expand the boundary of the Refuge to include large areas of land in the Nisqually Basin south of I-5. The majority of this land remains in large parcels used for agriculture. The central portion is protected from development through Thurston County's PDR program. Refuge acquisition could result in the reduction of some grazing opportunities and conversion of some agricultural lands to wetlands and riparian habitats, some of which could provide new public access areas. Since the goals of Refuge expansion are not incompatible with the PDR program, no significant adverse land use effects are anticipated. Nevertheless, the Service would have to comply with the terms of the easements, such as notification to Thurston County prior to initiation of certain permitted activities, if it acquires property within the PDR area.

In Thurston County, approximately 1,100 acres of agricultural land could be acquired for conservation purposes if Refuge acquisition is accomplished. Within the current agricultural component, approximately 840 acres are within the existing PDR program. As the Service acquires lands from willing sellers, lands would likely be converted to native habitats in support of migratory waterfowl, waterbirds, and a variety of other migratory birds. Crop production less favorable to wildlife and grazing would be replaced with a mosaic of freshwater wetland, riparian, and other native habitats. The impact to the overall agricultural economy would be minor.

In Pierce County, up to approximately 190 acres of agricultural land and approximately 100 acres on the East Bluff proposed for residential development could be acquired for conservation purposes. This could reduce planned housing in the area by up to approximately 200 units. This potential change would occur primarily in the area between Puget Sound and the City of DuPont, Washington.

The proposed Refuge expansion may affect the City of DuPont's Comprehensive Plan. However, the proposed expansion would only impact the City of DuPont's Comprehensive Plan if individual site plans are approved and lands within the proposed expansion were actually acquired by the Service. The extent of the effect on the City's Comprehensive Plan depends on the willingness of sellers and the amount of funds appropriated by Congress.

If the business and technology park remain as proposed and if this area were acquired by the Service, the City's configuration and economy could be impacted. A 3-acre community park on the north side of the business and technology park is proposed at a site overlooking Puget Sound above the mouth of Sequalitchew Creek. Until the exact location of the road has been determined, it is difficult to assess the impacts on the route and the cost of access from the road to the park.

The proposed Refuge expansion boundary extends up to the former DuPont Company dock site at the mouth of Sequalitchew Creek. Acquisition by the Service of lands in this area could affect the City of DuPont's adopted plans for a waterfront park. However, in reviewing the City's waterfront park plans, we find both the City's plans and the Service's proposal very similar. Both the City and the Service propose to provide trail access in nearly the same locations, and

the trails would provide access to the former dock site affording the public recreation opportunities in that area.

The proposed Refuge expansion in the Hoffman Hill area includes approximately 200 planned lots. If the Service acquired this area, the City may lose some of its ability to attract services, which is based on the number of homes constructed. However, it should be noted that individual site plans for the entire Hoffman Hill area have not yet been submitted for final approval, making it difficult to assess the impacts of acquisition by the Service.

Ultimately, the City's plan for balance is dependent upon final plat submittal and approvals. While Service acquisition may have some impacts to the local community and their planning efforts as described above, these impacts will be minimal. The impacts to the local economy would be minimized by revenue sharing payments which the Service pays to the County to help offset losses realized by lands being brought into the National Wildlife Refuge System.

The City of Olympia's McAllister Springs area contains approximately 256 acres of forested hillside, the Springs, and the wetlands headwaters of McAllister Creek. If acquired by the Refuge, this area would continue to be managed and protected as a water source for the City of Olympia.

Fort Lewis Military Reservation owns approximately 150 acres along the Nisqually River corridor in the Trotter's Woods area. If acquired by the Service or managed through a cooperative management agreement, Trotter's Woods would be managed to provide quality recreational fishing and protect and restore riparian habitat there. Cooperative efforts could also involve key partners, including the Nisqually Indian Tribe. A boat launching site in the area would continue to be available for use by the Nisqually Indian Tribe.

The future acquisition cost of each alternative is difficult to determine because the actual cost to purchase lands would be determined by an appraisal of each parcel of land and the type of interest acquired (fee title, conservation easement, or cooperative agreement) based on future unknown real estate market conditions. Purchase price could vary greatly on a particular parcel, depending on what the highest and best use of the land is at the time of purchase. Furthermore, all land within the proposed expansion area may not be acquired, with the amount depending upon willingness of the landowners to sell and the amount of acquisition funds appropriated by Congress. However, examining County-assessed values of properties within the proposed expansion area can provide rough approximation of the values involved if all lands were acquired in fee title. Based on data from the Pierce County and Thurston County Assessor Offices for the assessment year 2002, the assessed values of Alternatives B/C and Alternative D are approximately $20.2 million and $31.6 million, respectively. However, these values are relative, i.e., Alternative D is approximately 57% more than Alternatives B and C. We are unable to include the value of East Bluff property because the developer has not received final approval of development plans.

The Burlington Northern-Sante Fe right-of-way comprises approximately 110 acres of right-of-way within the East Bluff area. No change of ownership would be pursued with this landowner.

Thurston and Pierce counties would receive revenue payments in lieu of property taxes. This revenue sharing would be an additive process as more lands are acquired within the approved Refuge boundary. Based on assessed land values, annual payment would be approximately $45,700 to Pierce County and $106,000 to Thurston County if all properties in Alternative B were acquired in fee and Congress appropriated sufficient funds to cover 100% of the payments.

Incorporating additional lands within a new Refuge boundary would not affect private property rights unless the Service acquires lands from willing sellers. Landowners within the Refuge boundary retain all rights, privileges, and responsibilities of private land ownership including rights to access, control trespass, sell to any party, and develop their properties. Development of private land would continue to be subject to local regulations and land use zoning

The extent of affected agricultural lands and residents depends upon the number of willing sellers and acquisition funds appropriated by Congress. These factors suggest that changes in land ownership and land use would likely occur slowly over time. Within the proposed expansion area, it is unlikely that all agricultural lands would be taken out of production or that all residents would be relocated. Thus, the Service believes that the open space and the rural character of the Nisqually Valley would still be retained consistent with County plans.

It is also important to note that regardless of the Refuge expansion proposal, the character of the community is likely to change over time with the increasing pressures of population growth and urbanization in the area. Refuge expansion may, in fact, increase the chances that this part of the Nisqually Valley retains an open space character.

In Thurston County, the main County roads would remain consistent with County transportation plans. No significant adverse effects on the transportation system are anticipated. As lands are protected/acquired, approximately three parking areas would be developed by the Service to provide access to Refuge visitors south of I-5. Parking capacity south of I-5 is estimated to be about 60 cars. Some traffic increases on the existing roads would be expected in time associated with new visitor facilities. Refuge improvements would be designed to complement County strategies for interpreting natural and historic features in the lower Nisqually Valley. Traffic to Luhr Beach may increase depending on the extent of improvements and programming at this site. Parking capacity at Luhr Beach is estimated to remain at approximately 30 cars.

In Pierce County, the system of new roads adjacent to the East Bluff in Northwest Landing will develop as planned with only potentially minor changes to the setback distance from the East Bluff. Small pullouts and one to two parking areas would provide access to the Refuge lands along the East Bluff.

Special Status Lands

This alternative would increase the acreage of estuarine habitat in the Nisqually delta through restoration. This relatively small increase would not affect the National Natural Landmark designation. Although limited, parts of the Brown Farm Dike Trail would be breached and removed, the National Recreation Trail status would not change.

Enforcement of the closure of the current RNA to consumptive uses and winter boat activities would be compatible with national RNA policies and would benefit the RNA designation by providing stronger protection for natural processes.

There would be no changes in the public use program that would affect the PUNA area, shoreline designation, or National Recreation Trail.

4.8.2.3 Alternative C

General Land Use, Transportation, and Management

Transportation effects would be the largely the same as Alternative B, with the exception of a new trail under Alternative C. A new trail on Refuge and Tribal lands east of the Nisqually River would increase traffic on Mounts Road. A new parking lot and County Road improvements especially associated with the railway underpass may be needed to ensure safety.

Special Status Lands

Effects would be the same as Alternative B, with the exception that the amount of estuarine restoration and change in the Brown Farm Dike Trail would be greater and the RNA would be reduced in size. Benefits would be gained to the National Natural Landmark designation because it was based on the coastal salt marsh system in the delta, and restoration would enlarge and improve this biologically significant habitat. The loop trail would be shortened, but it is expected that this special designation would be retained. The National Recreation Trail would be re-described to reflect changes in trail configuration. The RNA would be reduced by 166 acres, to 627 acres total, to accommodate waterfowl hunting. This would remove the added protections provided by the RNA designation to portions of tideflats and open water, requiring the RNA to be redefined.

4.8.2.4 Alternative D (Preferred Alternative)

General Land Use, Transportation, and Management

Implementing Alternative D could result in approximately 3,479 acres within Thurston and Pierce counties being added to the existing approved Refuge boundary. This addition could include approximately 512 acres of bluff habitat and 2,963 acres of floodplain, riparian, and wetlands. The effects of land use changes on agricultural, residential development, the City of Olympia, and military lands would be the same as for Alternatives B and C, with additional changes described below.

This alternative would expand the Refuge's boundary more extensively than any of the other alternatives. A 2.9-mile stretch of the lower Nisqually River could potentially be added to the Refuge. If a cooperative management agreement or other land protection measures were developed on Fort Lewis lands, it would be designed to accommodate or complement the Army's mission. The remainder of this land in private ownership consists of the river's natural floodplain, comprised of meander loops and wetlands. Since habitat restoration would enhance

and complement existing land use, rather than displace current use, land use effects from this alternative are expected to be positive.

Within the Nisqually Valley, the Holroyd Gravel operation, encompassing approximately 300 acres within two permit areas, could eventually be reclaimed and changed from mineral overlay to conservation purposes. Land use effects would vary depending on whether and at what stage acquisition were to occur. For example, if gravel resources were already removed, land use changes would be minimal.

The assessed value of Alternative D is approximately $31.6 million. The values of the alternatives are relative (i.e., Alternative D is approximately 57% more than Alternatives B and C).

Under Alternative D, Thurston and Pierce counties' revenue sharing payments in lieu of property taxes would be greater since the potential for acquired lands is greater. Based on assessed land values, annual payment would be approximately $45,700 to Pierce County and $191,400 to Thurston County if all properties in Alternative D were acquired and Congress appropriated sufficient funds to cover 100% of the payments. Private property rights would remain the same as described for Alternatives B and C.

Transportation effects would be largely the same as in Alternatives B and C. Increased expansion in Alternative D south of I-5 includes the Holroyd Gravel operation. Acquisition of this property could reduce the amount of truck/hauling traffic in the lower Nisqually Valley. Although acquisition of this property is not expected in the foreseeable future, this could have related positive effects such as reducing noise and dust in the study area. The additional acreage proposed in Alternative D may require one or two additional small Refuge parking lots for trails, fishing access, or hunting. A total parking capacity of approximately 140 cars is proposed throughout the proposed expansion area and on the east side of the Nisqually River (south of I-5 - 75 cars; Luhr Beach - 30 cars; East Bluff - 10 cars; trailhead on the east side of the Nisqually River - 25 cars). Parking scattered in locations throughout the area would tend to disperse traffic and provide a diverse array of wildlife-oriented recreational opportunities.

Special Status Lands

Effects would be the same as Alternative B, with the exception that the amount of estuarine restoration and change in the Brown Farm Dike Trail under Alternative D would be greatest among all alternatives. In addition, the RNA would be reduced by 73 acres to 720 acres to accommodate hunting, removing added protections to sensitive river mouth habitats, but areas east of the river channel would be retained as RNA. The 73-acre portion to be removed includes 37 acres of mudflat and 36 acres of saltmarsh. However, a new 44-acre area would be added to the RNA along the south end, increasing the size of the RNA to a total of 764 acres. This includes 43 acres of saltmarsh, helping to reduce the effects of this deletion. However, the 43 acres of saltmarsh that would be added are not directly equivalent to the 36 acres of saltmarsh removed because the saltmarsh found at the mouth of the Nisqually River is undoubtedly a more complex saltmarsh, with more sloughs and channels than is found in the 44 acres to the south where less tidal flushing occurs. The RNA boundary would need to be administratively altered. The National Natural Landmark designation would benefit the most due to the largest increase in

restored tidal salt marsh area. A limited amount of dike trail would remain, augmented by a boardwalk trail extension, providing access to a variety of habitats, including estuarine and Puget Sound habitats. The National Recreation Trail would be negatively affected due to the dike removal and reduction in trail length; however, the Service retains full latitude to control or restrict public uses in favor of wildlife resources (Waddell 1981; Watt 1981; Heritage Conservation and Recreation Service undated). The National Recreation Trail would be retained, but re-described to reflect the new trail configuration. No changes to other designations are expected.

4.8.3 Effects of Refuge Management Economics on the Regional Economy

This section discusses direct economic effects on the regional economy resulting from local economic contributions by the Refuge. The Refuge's annual base budget comprises most of the Refuge's annual funding. In typical years, approximately 85 to 90% of this budget is spent on salaries and employee benefits. Since staff salaries comprise the most significant portion of revenue expenditure, Refuge staffing levels are generally proportional to the annual budget. The remainder is usually spent on routine operating expenses, equipment, supplies, contractors, vendors, travel, and training. Other revenue sources include supplemental annual funding such as non-game migratory bird funding and challenge cost-share grants, both of which are used to fund special projects and wildlife investigations. Since these funding sources are competitively awarded and fluctuate from year to year, they cannot be accurately factored into an economic analysis. In addition, the Refuge generates a small amount of income from visitors through entrance fees. Entrance fee revenue is spent on visitor services and facilities and would likely continue to be proportional to visitation.

Because most Refuge funding comes from the Federal government and other sources external to the local economy, the Refuge's payroll and other expenditures comprise net revenue for the local economy. Thus, every Federally supported job at the Refuge results in local expenditures and indirectly supports additional employment in the region. The relative number of jobs in the local economy that are generated by each externally funded job is known as the multiplier. According to the Washington State Economic Model used by the State's Department of Revenue, the economic multiplier for Service employment is 1.9; thus, each Refuge job generates an additional 0.9 jobs in the local economy (Bertoun, pers. comm.).

Unlike other resource areas, effects on the regional economy are not expected to differ between alternative actions for Refuge expansion, restoration, or public use program. This is because the principal economic driver - the Refuge's annual budget - is mostly derived from staff salaries. Since staffing needs are not specifically tied to alternative actions for the separate programs involving Refuge expansion, restoration, or public use program, there is no accurate way to distribute the analysis by these individual topics. Instead, effects to the regional economy can only accurately be evaluated for each alternative as a whole, as presented below.

4.8.3.1 Alternative A

Under the No Action Alternative, the Refuge's annual base budget and staffing are expected to remain comparable to historical funding and staffing levels. In 2000, the Refuge's base budget was $565,840, sufficient to support the equivalent of approximately 8 full time equivalent (FTE)

employees. Due to supplemental annual funding secured that year by the Refuge, actual staffing was closer to 10 FTEs, but supplemental funding is variable and thus cannot be used as a base for future projections. Under this alternative, staffing would likely remain evenly distributed among management, administrative, biology, public use, and maintenance functions. Assuming no change in the Refuge's base budget, the Refuge would continue to indirectly support at least 7.2 jobs and therefore continue to have minor positive effects on the regional economy.

4.8.3.2 Alternative B

This alternative would triple staffing to 24 FTEs, compared to the No Action Alternative, and almost triple funding to $1,615,000. Each staffing category would be increased with major increases to biology (four new employees) and public use (five new employees). This alternative would also indirectly maintain approximately 21.6 jobs, resulting in a positive effect on the regional economy.

4.8.3.3 Alternative C

Funding and staffing would more than triple under Alternative C to 26 FTEs and $1,763,750, compared to the No Action Alternative. Employment would increase in each staffing category similar to Alternative B; however, an additional Environmental Education Specialist would be added to the payroll. This alternative would be expected to indirectly support at least 23.4 jobs, resulting in a positive effect on the regional economy.

4.8.3.4 Alternative D (the Preferred Alternative)

In terms of financial contribution and job creation, Alternative D would have the largest positive effect on the regional economy of the four alternatives. The salary and operating costs would be approximately $1,828,750, representing an increase of $1,262,910 in expenditure over the No Action Alternative, most of which would be directed to the Refuge's payroll and contribute directly to the regional economy. One major staffing difference between this alternative and Alternative C is the addition of two biology positions, for a total of 29 FTEs. This alternative would indirectly support approximately 26.1 jobs in the regional economy.

4.8.4 Effects to Recreation Economics

The following analysis assumes no change in the Refuge's fee structure ($3.00 per family daily entrance fee or admission by Golden Eagle, Golden Age, Golden Access Passport, Refuge Annual Pass, or a Federal Duck stamp). In 2000, the Refuge collected $39,781 in entrance fees. The sales outlet operated in the Visitor Center is run by a non-profit partner, the Nisqually Refuge Cooperating Association, which covers a portion of its operating costs from limited sales of literature and related products. In 2000, the sales outlet earned approximately $20,000. Prior to construction of new visitor facilities, the Refuge averaged approximately 80,000 visitors per year who participated in a variety of wildlife-dependent recreational and educational activities, including wildlife observation, photography, interpretation, environmental education, and fishing. The main activities are trail use and wildlife observation. Visitation increased to

approximately 100,000 in 2000, with the increase primarily attributed to the new visitor facilities.

Analysis of data collected through the Service's National Survey of Fishing, Hunting, and Wildlife Associated Recreation has shown that recreational visits to National Wildlife Refuges generate substantial economic activity. In 1995, people visited Refuges more than 27.7 million times for recreation and environmental education. They spent more than $401 million in sales which employed an estimated 10,000 people and generated an additional $162.9 million in employment income (Laughland and Caudill 1997). Non-residents spend about 3 times more than local visitors for recreational activities due to spending more on transportation, restaurants, lodging, and other purchases (Laughland and Caudill 1997). The Service estimates that 75% of Nisqually NWR visitors travel less than 50 miles, 20% are Washington State residents who travel more than 50 miles, and the remaining 5% live out of state. Per person, per day expenditures are estimated to be low since the average visitor lives in relative proximity to the Refuge; however, the number of visitors is substantial enough to have a positive effect on the local economy. For example, using regional factors calculated by Laughland and Caudill (1997), 100,000 annual visitors to Nisqually NWR could have spent between $1.7 and $2.3 million at local businesses, depending on the proportion of those traveling from out of the area.

4.8.4.1 Alternative A

Refuge Expansion

Since no Refuge expansion would occur under this alternative, there would be no economic effects directly related to recreation or public access. Changes to recreation and recreation-derived economics at Nisqually NWR would be driven by factors other than Refuge expansion, such as regional population growth, economic development, or changes within the existing Refuge boundary.

Habitat Restoration

Recreation and public use could increase slightly as a consequence of enhanced freshwater habitats under this alternative, but the effect would not be expected to be significant, particularly since long-term, freshwater habitats would be expected to deteriorate as reed canary grass spreads.

Public Use Program

Alternative A is expected to generate relatively neutral effects on recreation; hence, minor positive recreation-derived economic effects should balance negative ones. New facilities, which were a major factor in increases in visitation in 2000 and 2001, would continue to be provided in all alternatives, and a continued upward trend in visitation resulting in increased economic benefits would be expected.

4.8.4.2 Alternative B

Refuge Expansion

Moderate Refuge expansion under this alternative would be expected to provide additional areas and new habitats open to visitor use, potentially increasing visitation and revenues for the Refuge. No negative effects to recreation economics would be anticipated. Related positive economic effects such as increased revenue for the Refuge and region would be expected to be proportionate with increased visitation, and would depend on what areas were acquired.

Habitat Restoration

Minor positive recreation and public use effects resulting from restoration of muted estuarine habitat under this alternative would be expected to translate into minor positive recreation economic effects, if visitation increases in response to habitat restoration and management enhancements.

Public Use Program

Economic effects derived from recreation expenditures are not expected to be significant under this alternative, and minor positive and negative effects would likely offset one another. A small amount of increased expenditure may result from 15,000 additional student visits (20,000 total) each year. Elimination of unauthorized hunting throughout the Refuge and RNA closures to consumptive uses may slightly depress visitation, but these changes would be expected to be very small, especially since hunter visits are a very small percentage of annual visitation. Because other large, adjacent Refuge or State areas are available, significant changes in visitation and local expenditures as a result of these restrictions would not be expected. In addition, increased visitation observed with the opening of new facilities would be expected to continue, and a continued upward trend in visitation resulting in increased economic benefits would be expected.

4.8.4.3 Alternative C

Refuge Expansion

Refuge expansion under this alternative would be the same as Alternative B, as would recreation economic effects, such as increased revenue for the Refuge and region, proportionate with increased visitation.

Habitat Restoration

Restoration of 50% of the diked interior to estuarine habitat under this alternative would have a mixed effect on recreation and public use and indirectly on recreation economics. The reduction in trail length may have a minor effect on visitation, resulting in some decrease in expenditures. However, the effects of the new facilities, new trails, improved habitat, and more student visits would be expected to contribute to an increasing trend in visitation, increasing economic benefits. Thus, long-term recreation economic effects would improve as visitation to the Refuge increases over time. In the long run, recreation economic effects would likely be positive under

this alternative as a result of habitat restoration, new public facilities, and management changes.

Public Use Program

New facilities would continue to be provided, which would be expected to produce a continued increasing trend in visitation over time, increasing expenditures. Increases in visitation may be dampened somewhat by the reduced trail length; however, new trails, particularly on the east side of the river, would attract visitation, providing access to a new area and contributing to increased expenditures. The addition of 10,000 student visits over Alternative A would also contribute to increased economic benefits.

4.8.4.4 Alternative D (Preferred Alternative)

Refuge Expansion

Of all the alternatives under consideration, Alternative D would provide for the maximum amount of Refuge expansion. Recreation economic expansion is expected to be proportionate to increased recreation and public access resulting from this expansion. Increased revenue for the Refuge and region would be greater under Alternative D than for the other alternatives and would depend on what areas were acquired.

Habitat Restoration

This alternative would be similar to Alternative C except that an additional 20% of the Refuge would be restored to estuarine habitat, resulting in a similar mix of recreation-based economic effects. Freshwater areas would be reduced; however, management would be most intensive, providing greater wildlife densities, which may attract visitors. In addition, these more substantial estuarine restoration efforts could become a draw for visitors interested in environmental restoration, attracting visitors from other areas who would spend time and money in the area, potentially resulting in some regional economic gains.

Public Use Program

Recreation-related economic effects under this alternative are expected to be comparable to Alternative C, except that the reduction in trail length would be greater and the main trail would no longer be a loop, resulting in some decrease in visitation. However, the effects of new facilities, new trails, improved habitat, and more student visits would be expected to increase visitation and related economic benefits.

4.8.5 Effects to Commercial Shellfishing

4.8.5.1 Alternative A

Under the No Action Alternative, there are no anticipated effects to commercial shellfishing.

4.8.5.2 Alternative B-D

Since commercial shellfishing is currently closed in the Nisqually Reach, effects from habitat restoration, Refuge expansion, and public use program activities proposed in the action alternatives are expected to be negligible. In the event that commercial shellfishing is reestablished in the area after implementation of Alternative B, C, or D, there could be a temporary negative effect from siltation associated with dike removal. The anticipated long-term effects are a healthier estuary, which should improve commercial shellfishing.

4.9 Summary of Effects

Table 4.9-1 summarizes potential effects for each of the four alternatives.

Table 4.9-1. Summary of Potential Effects of Alternatives A, B, C, and D.

Resource Issue or Concern	Alternative A	Alternative B	Alternative C	Alternative D
PHYSICAL ENVIRONMENT				
Hydrological connection between restored areas and Puget Sound, Nisqually River, and McAllister Creek.	EC	SH	MH	CH: The Nisqually River would be allowed to move more freely, the entire McAllister Creek system would be restored, and less flood waters would flow into the diked area during flood events.
HABITATS				
Estuarine	EC	MH: 318 acres muted estuarine and 140 acres of full estuarine habitat with a connection to McAllister Creek.	MH: 515 acres with a full tidal connection to Puget Sound, and some of Nisqually River and McAllister Creek.	CH: 699 acres with full tidal connection to Puget Sound, Nisqually River, and all of McAllister Creek.
Freshwater Wetland	SH: Limited improvements.	MH: 542 acres improved management of diked area and protection of some areas south of I-5.	CH: 447 acres improved management with a higher proportion of freshwater wetlands than grasslands and protection of some areas south of I-5.	MH: 263 acres improved management with a high proportion of freshwater wetlands and some grasslands and protection of some areas south of I-5.
Riverine and Riparian Restoration Increased protection	 SH EC	 SH MH: Additional 325 acres.	 MH: Additional 38 acres. MH: Additional 325 acres.	 MH: Additional 38 acres. MH: Additional 1,011 acres.
Upland Upland Forests Grasslands	 EC SL	 MH: Increased protection of 803 acres. ML: Some loss of grasslands within diked area, but some increased protection in expansion area.	 MH: Increased protection of 803 acres. CL: Loss of grasslands within diked area, but some increased protection in expansion area.	 MH: Increased protection of 1,262 acres. CL: Loss of grasslands within diked area, but some increased protection in expansion area.

EC = existing conditions; SH = slightly higher (or improved) than existing conditions; MH = moderately higher (or improved) than existing conditions; CH = considerably higher (or improved) than existing conditions; SL = slightly lower (or decreased) than existing conditions; ML = moderately lower (or decreased) than existing conditions; CL = considerably lower (or decreased) than existing conditions.

Table 4.9-1. Summary of Potential Effects of Alternatives A, B, C, and D.

Resource Issue or Concern	Alternative A	Alternative B	Alternative C	Alternative D
EXOTIC PLANTS				
Reed canary grass	SL: Continued dominance and spread within diked area.	MH: Improved control within diked area and elimination in restored estuarine areas.	CH: Improved control within diked area and elimination in restored estuarine areas.	CH: Improved control within diked area and elimination in restored estuarine areas.
FISHERIES HABITATS AND RESOURCES	EC	SH	MH	CH: Greatest estuarine restoration and riparian restoration and protection, contributing to salmon recovery.
BIRDS				
General Effects	EC	Slightly more estuary; somewhat improved freshwater wetlands; increased habitat protection in expansion area; and more sanctuary.	More estuary; improved freshwater wetlands; restored riparian; increased habitat protection in expansion area; and most sanctuary, including McAllister Creek.	More estuary; improved freshwater wetlands; restored riparian; largest increased habitat protection in expansion area, particularly riparian; and more sanctuary.
Waterfowl	EC	MH	MH - CH	CH
Waterbirds	EC	MH	SH - MH	SH - MH
Seabirds	EC	SH	MH	CH
Shorebirds	EC	SH	MH - CH	CH
Landbirds	EC	SL	SH - MH	SH - MH
MAMMALS				
Marine	EC	SH	MH	MH
Land	EC	SL: Slight decrease in diked areas; increased upland forest and freshwater wetland protection in expansion area.	ML: Some decrease in diked areas; increased upland forest and freshwater wetland protection in expansion area.	ML: Largest decrease in diked areas; largest upland forest and freshwater wetland protection in expansion area.
REPTILES AND AMPHIBIANS	EC	SL	SL	SL

EC = existing conditions; SH = slightly higher (or improved) than existing conditions; MH = moderately higher (or improved) than existing conditions; CH = considerably higher (or improved) than existing conditions; SL = slightly lower (or decreased) than existing conditions; ML = moderately lower (or decreased) than existing conditions; CL = considerably lower (or decreased) than existing conditions.

Table 4.9-1. Summary of Potential Effects of Alternatives A, B, C, and D.

Resource Issue or Concern	Alternative A	Alternative B	Alternative C	Alternative D
INVERTEBRATES				
Marine Terrestrial	EC EC	SH SL: Slight decrease in diked areas; increased upland forest and freshwater wetland protection in expansion area.	MH ML: Some decrease in diked areas; increased upland forest and freshwater wetland protection in expansion area.	CH ML: Largest decrease in diked areas; largest upland forest and freshwater wetland protection in expansion area.
ENDANGERED & THREATENED SPECIES	EC	SH	MH	CH
SPECIAL USES				
Haying	EC	SL: Haying area reduced by 5 acres.	ML: Haying area reduced by 69 acres.	CL: Haying area reduced by 118 acres.
EDUCATIONAL AND RECREATIONAL OPPORTUNITIES				
Environmental Education	EC	CH	MH	MH
Wildlife Observation, Interpretation, and Photography	EC	SH	MH: Trail length is shortened but improved quality with diversified viewing opportunities; new eastside trail.	MH: Trail length is shortened but improved quality with diversified viewing opportunities; new eastside trail.

EC = existing conditions; SH = slightly higher (or improved) than existing conditions; MH = moderately higher (or improved) than existing conditions; CH = considerably higher (or improved) than existing conditions; SL = slightly lower (or decreased) than existing conditions; ML = moderately lower (or decreased) than existing conditions; CL = considerably lower (or decreased) than existing conditions.

Table 4.9-1. Summary of Potential Effects of Alternatives A, B, C, and D.

Resource Issue or Concern	Alternative A	Alternative B	Alternative C	Alternative D
Waterfowl Hunting				
Acreage	EC	CL: Refuge land posted closed to hunting	CH: 713 acres of Refuge land (1,170 acres consolidated hunt area with State lands).	MH: 191 acres of Refuge land (total 808 acres hunt area with State lands)
Quality	EC	SH: Eliminate boundary confusions	CH: 3 day/wk hunt, 25-shell limit, eliminate boundary confusions.	MH: Eliminate boundary confusions, 25-shell limit.
Conflict with other users	EC	SL - ML	CL	SL - ML
Available Sanctuary	EC	MH	CH: Hunting removed from McAllister Creek.	MH
Fishing and Shellfishing	EC	MH: Additional location at Trotter's Woods and disabled access location at Luhr Beach.	CH: Additional locations at Trotter's Woods, eastside property, and disabled access location at Luhr Beach.	MH: Additional locations at Trotter's Woods, eastside property, and disabled access locations at Luhr Beach and Nisqually, but loss of McAllister Creek site with possible replacement if lands acquired south of I-5.
Boating	EC	ML: 5 mph speed limit, seasonal closure of RNA.	ML: 5 mph speed limit, seasonal closure of RNA.	ML: 5 mph speed limit, seasonal closure of RNA.
CULTURAL RESOURCES				
	EC: Some effects to Brown Farm Dike from needed repairs.	MH: Some modification and removal of Brown Farm Dike; majority of dike remains; improved interpretation and EE of cultural resources; and improved protection of sites in expansion areas.	SH: Portions of Brown Farm Dike removed; improved interpretation and EE of cultural resources; improved protection of sites in expansion areas.	SL - SH: Majority of Brown Farm Dike removed; improved interpretation and EE of cultural resources; largest protection of sites in expansion areas.

EC = existing conditions; SH = slightly higher (or improved) than existing conditions; MH = moderately higher (or improved) than existing conditions; CH = considerably higher (or improved) than existing conditions; SL = slightly lower (or decreased) than existing conditions; ML = moderately lower (or decreased) than existing conditions; CL = considerably lower (or decreased) than existing conditions.

Table 4.9-1. Summary of Potential Effects of Alternatives A, B, C, and D.				
Resource Issue or Concern	**Alternative A**	**Alternative B**	**Alternative C**	**Alternative D**
SOCIOECONOMICS				
Special Status Lands Research Natural Area	EC	CH: Removal of consumptive uses and seasonal boat closure.	MH: Removal of consumptive uses and seasonal boat closure, but reduced by 166 acres.	MH: Removal of consumptive uses and seasonal boat closure, but reduced by 73 acres at river mouth; 44 acres added at south end.
National Recreation Trail	No change in status.	No change in status.	SL: Retain status, but re-describe.	ML: Retain status, but re-describe.
National Natural Landmark	No change in status.	No change in status.	SH: Enlarged area of designated habitat.	MH: Enlarged area of designated habitat.
Regional Economy	EC	SH	MH	MH
Recreation Economics	EC	SH	MH	MH

EC = existing conditions; SH = slightly higher (or improved) than existing conditions; MH = moderately higher (or improved) than existing conditions; CH = considerably higher (or improved) than existing conditions; SL = slightly lower (or decreased) than existing conditions; ML = moderately lower (or decreased) than existing conditions; CL = considerably lower (or decreased) than existing conditions.

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4.10 Cumulative Effects

This section addresses the potential cumulative effects for all of the alternatives and is intended to consider the activities on Nisqually NWR in the context of other actions on a larger temporal and spatial scale.

There is a clear trend in western Washington, particularly in the Puget Sound region, of increasing development and associated habitat loss. Additional residential and commercial development is planned throughout much of the local area, as well as the south Puget Sound region. Within this context of increasing development, all of the alternatives would preserve existing habitat on the Refuge. By expanding the Refuge boundary, the action alternatives would also increase the amount of habitat that would be protected and restored in the lower Nisqually River watershed. Active restoration of the land acquired under the action alternatives would increase the carrying capacity of the Nisqually delta for fish and wildlife. Any of the action alternatives would also complement other regional habitat acquisition or protection programs under consideration by local and State agencies, Fort Lewis, the Nisqually Indian Tribe, the Nisqually River Council, and the Nisqually River Basin Land Trust, resulting in positive cumulative effects to fish and wildlife. Alternative D, which would potentially almost double the size of the Refuge by protecting an additional 3,479 acres of habitat, would also provide an improved, continuous wildlife corridor along part of the lower Nisqually River, including a portion of a proposed RNA on Fort Lewis (U.S. Army) property. In addition, this alternative would offer greater watershed protection by preventing erosion and contamination associated with development on steep slopes and in the riparian and floodplain areas.

Perhaps the most significant effect of the action alternatives is the restoration of historic estuarine wetlands on the Refuge. Over the last 150 years, up to 80% of estuarine habitat in Puget Sound has been lost, contributing to the decline of many fish and wildlife that depend on estuaries (Dean et al. 2000), including several salmon species. A number of Pacific salmonid species are now listed as threatened or endangered under the Endangered Species Act. In recent years, numerous programs in the Puget Sound area have been developed to protect and improve salmon habitat to meet the recovery requirements of the Endangered Species Act. Very few of these programs, however, involve major estuarine restoration, and none would substantially increase the amount of this habitat in the region. Few places exist where this can occur. Alternatives B, C, and D, would add 140, 515, and 699 acres of full estuarine wetland, respectively, to the Nisqually delta. Any of these alternatives represent a substantial increase in the amount of estuarine wetland in Puget Sound, with Alternative D providing the most significant contribution. Implementation of this alternative would increase this type of habitat by 46% in south Puget Sound. Combined with other ongoing programs to restore/improve salmon habitat, the action alternatives would represent substantial positive cumulative effects to fish and wildlife that use estuaries.

Cumulative effects involving the public use program would be an overall improvement in the quality of environmental education and wildlife-dependent recreation opportunities in south Puget Sound. Priority public use opportunities would increase or improve with the establishment of new or enhanced public facilities and access. Human disturbance and conflicts

between users would be reduced, and wildlife sanctuary would be greatly improved on the Refuge. These improvements would also help address the effects that will result as the human population continues to increase rapidly in the region and visitation grows over time.

4.11 Irretrievable and Irreversible Commitment of Resources

The restoration of historic estuarine habitat necessitates the removal of portions of dikes and the conversion of some freshwater wetlands under all action alternatives. Although it would be possible to reconstruct the dike system and reestablish freshwater wetlands, this would be unlikely to occur once estuarine habitat is restored. In addition, the establishment of new public facilities and trails represents an irreversible diminishment of biological productivity in those sites. Alternatives C and D would also reduce the size of the RNA on the Refuge to provide for a waterfowl hunting program, thus improving this public use, but reducing this area of greater protection. Reversing this change in the RNA would be possible but difficult in the future.

4.12 Short-term Uses and Long-term Productivity

The No Action Alternative would not effectively maintain or improve long-term productivity. All of the action alternatives are focused on the long-term enhancement and expansion of habitat for native species. The Preferred Alternative would be most effective at enhancing the long-term productivity of the Refuge ecosystem to contribute toward the maintenance and recovery of native fish and wildlife populations. There may be some short-term loss of freshwater wetlands from conversion to estuarine habitat if additional freshwater wetlands cannot be acquired at the same time and rate. However, the simultaneous improvement of remaining freshwater habitats on the Refuge would increase capacity within those areas. In the longer term, expansion under the action alternatives would result in additional opportunities for freshwater wetlands and benefit the fish and wildlife species that use these habitats.

4.13 Unavoidable Adverse Effects

The Preferred Alternative would result in unavoidable adverse effects to non-native grassland and shrub-scrub habitats due to the decrease in overall amounts of these habitat types. Refuge expansion and restoration would provide some of this kind of habitat; however, management in these areas would focus on freshwater wetland enhancement. A limited number of relatively common wildlife species depend solely or largely on these two kinds of habitat and would be most affected by these reductions. The restoration of historic estuarine habitat would provide very positive overall environmental effects and would benefit many more species that are higher priority to recover or maintain. Freshwater wetland acreage would decrease within the diked area; however, improved management would provide wildlife benefits, and expansion would provide additional opportunities to increase the overall amount and quality of freshwater wetlands in the lower Nisqually River watershed.

Habitat restoration and reducing wildlife disturbance necessitates changes in the public use program that would have site-specific adverse effects, including changes in trail configuration, the elimination of the McAllister Creek bank fishing area, and new boating restrictions. However, new or improved opportunities would be provided as part of the Preferred Alternative, providing overall improvements in these programs.

Habitat and species monitoring undertaken as part of the Preferred Alternative would assist Refuge staff in adapting management approaches to maximize resource benefits.

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