CHAPTER 4. AFFECTED ENVIRONMENT

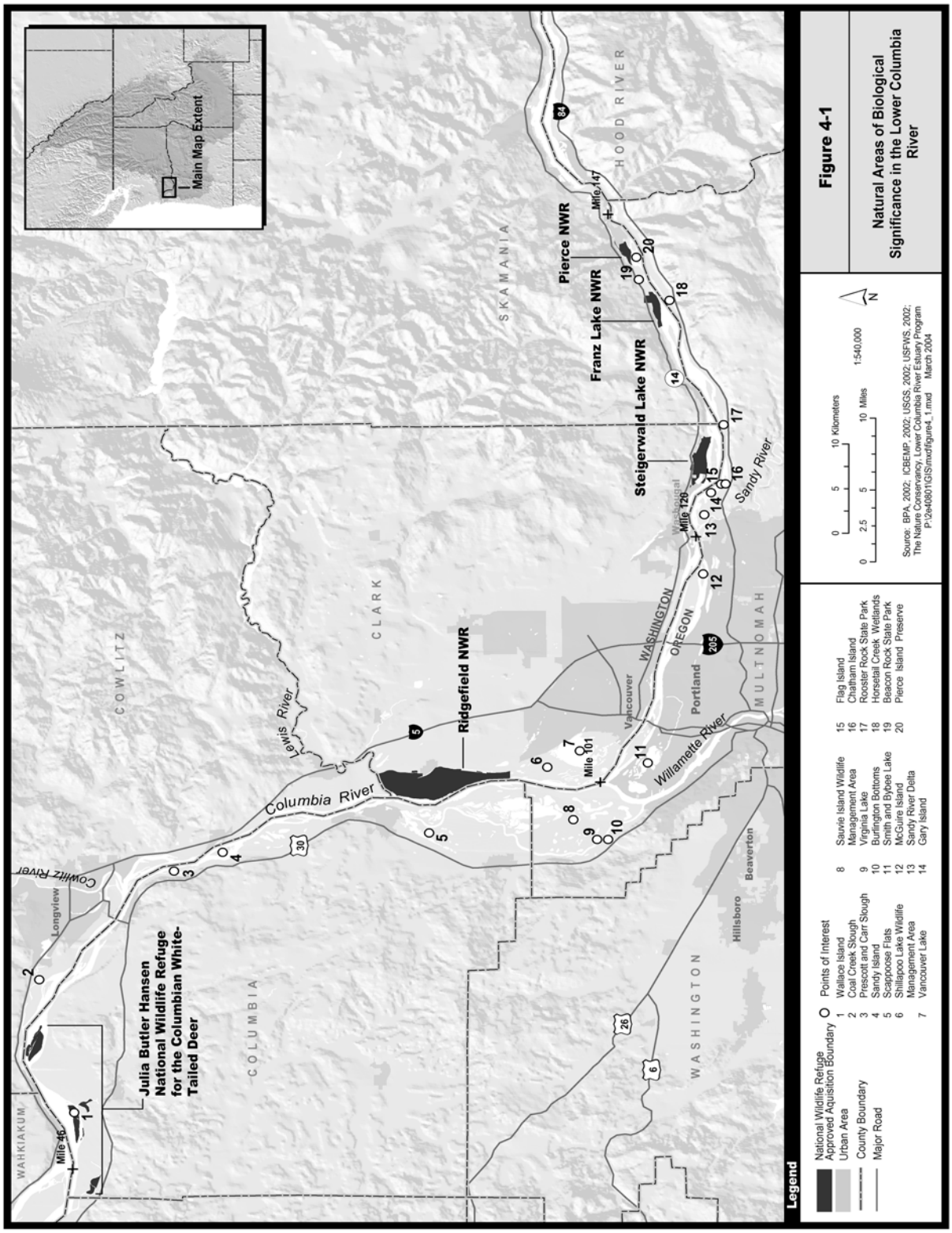
Lower Columbia River Ecosystem

The three Refuges addressed in this CCP are positioned in the lower part of the Columbia River. The lower Columbia River ecosystem extends 146 river miles, from Bonneville Dam to the Pacific Ocean (Figure 4-1). The basin of the lower Columbia River includes the basins of lower tributary streams, the largest of which are the Willamette, Cowlitz, Kalama, Sandy, and Lewis Rivers.

The Columbia River runs a varied course from the Bonneville Dam to the Pacific Ocean. It is relatively narrow–925-feet-wide–directly below the dam. After it emerges from the Columbia River Gorge at Steigerwald Lake Refuge, about 20 miles east of Portland, the river valley widens to include a broad floodplain. Elongated islands divide the river and form sloughs and side-channels in the formerly marshy lowlands. The floodplain expands around the confluence of the Columbia and Willamette Rivers. Here, the sloughs and lakes of North Portland, the Vancouver lowlands, Sauvie Island, and Ridgefield Refuge contain the Portland metropolitan area's last major remnants of the wetland and riparian system formerly nourished by annual flooding of the non-dammed rivers. Downstream from St. Helens, Oregon, the Columbia River cuts through the coast range, a passage marked by steep-shouldered bluffs and broad alluvial floodplains. The river channel, dotted with low islands of deposited sediments throughout its lower reaches, opens out below Skamokawa, Washington, into several broad bays that extend more than 30 miles to the Pacific Ocean. At its mouth below Astoria, Oregon, the river passes between two jetties approximately two miles apart as it enters the Pacific Ocean.

Historically, flooding within the Columbia River was the product of regional precipitation, the rate and volume of snowmelt, and synchronization of runoff between the Columbia and Snake River drainages. Construction of over 200 dams on the Columbia River and its tributaries has dramatically altered the historic hydrology. Dams now impose additional water level fluctuations to meet demands for hydro-electricity, agriculture, navigation, pool recharge, recreation, fisheries, and water quality priorities.[32] Spring flood elevations on the lower Columbia River average 37 percent lower today than prior to dam construction.[19] Regulated winter flows are typically less than 200,000 cubic feet per second (cfs). Peak flows in May and June have declined from about 600,000 cfs to 350,000 cfs. Prior to dam construction, average spring floods regularly inundated 170,000 acres of bottomland along the lower Columbia River for periods of up to 60 days. Major spring flood events inundated up to 300,000 acres of the lower Columbia River floodplain.[8]

Over half of the historic riverine wetlands in the lower Columbia River below Bonneville Dam have been lost or substantially degraded as a result of diking, draining, filling, dredging, and flow regulation.[8] Since 1948, the most notable habitat changes have occurred in the vicinity of the


Main Map Extent
Julia Butler Hansen National Wildlife Refuge for the Columbian White-Tailed Deer
Ridgefield NWR
Steigerwald Lake NWR
Franz Lake NWR
Pierce NWR
Columbia River
Lewis River
Willamette River
Sandy River
Cowlitz River
Mile 46
Mile 101
Mile 128
Mile 147
Longview
Vancouver
Portland
Beaverton
Hillsboro
Washougal
WAHKIAKUM
COWLITZ
CLARK
SKAMANIA
HOOD RIVER
COLUMBIA
MULTNOMAH
WASHINGTON
OREGON
Legend
National Wildlife Refuge
Approved Aquisition Boundary
Urban Area
County Boundary
Major Road
Points of Interest
1 Wallace Island
2 Coal Creek Slough
3 Prescott and Carr Slough
4 Sandy Island
5 Scappoose Flats
6 Shillapoo Lake Wildlife Management Area
7 Vancouver Lake
8 Sauvie Island Wildlife Management Area
9 Virginia Lake
10 Burlington Bottoms
11 Smith and Bybee Lake
12 McGuire Island
13 Sandy River Delta
14 Gary Island
15 Flag Island
16 Chatham Island
17 Rooster Rock State Park
18 Horsetail Creek Wetlands
19 Beacon Rock State Park
20 Pierce Island Preserve
0 2.5 5 10 Miles
0 5 10 Kilometers
1:540,000
N
Source: BPA, 2002; ICBEMP, 2002; USGS, 2002; USFWS, 2002; The Nature Conservancy, Lower Columbia River Estuary Program
P:\2e408011GIS\mxd\figure4_1.mxd March 2004
Figure 4-1
Natural Areas of Biological Significance in the Lower Columbia River

Portland/Vancouver area.[35] Urban and other developed habitat has increased dramatically, with a corresponding decrease in wetland, riparian scrub-shrub, coniferous forest, broadleaf forest, and agricultural habitat.

Despite these dramatic habitat losses, numerous natural areas remain in the lower Columbia River with high levels of biological significance (Figure 4-1). Each of these sites contains important habitats for fish and wildlife. Collectively, the Gorge Refuges and the remaining biologically important areas contribute to the maintenance of biological diversity and integrity and ecosystem health in the lower Columbia River system.

Physical Environment

Geology and Geomorphology

From dramatic cliffs surrounding Pierce Refuge to open prairies of Steigerwald Lake Refuge, the Columbia River Gorge encapsulates much of the geological history of the Pacific Northwest. Landforms, stratigraphy, and rocks found in the Gorge reflect the collision of crustal plates, eruptions of innumerable volcanoes, enormous landslides, and floods beyond human experience. Visitors to the Gorge can see the Columbia River slicing through these landforms and visualize this remarkable story.

Geology of the Columbia River Gorge revolves around the collision of North America with the oceanic crust under the Pacific Ocean. This process has been occurring for millions of years. The Cascade Range of today is only the most recent of a series of continental margin mountains that began forming about 17 million years ago. Beacon Rock, west of Pierce Refuge, is the plug of an earlier continental margin volcano. Many of what are now the highest points in the Gorge, such as Hamilton Mountain above Pierce Refuge, were once channels of the Columbia River that filled with lava (basalt) and were subsequently uplifted by the rise of the Cascade Range. The broad valley Portland and Vancouver occupy was formed by spreading of the continental crust.

The complex nature of crustal collisions is reflected in the Gorge. Layers of rock in Gorge walls that were once level, are tipped to the south by as much as 10 degrees. An overview of the Gorge and areas to the east reveals that these tipped layers are on the southern flank of a huge wrinkle in the continental crust, one of several features known as the Yakima Fold Belt. The Yakima fold has contributed to spectacular events such as giant landslides. The most famous of the slides is the Bonneville, located just up the Columbia from Pierce Refuge. The Bonneville Landslide occurred only about 500 years ago, dammed the Columbia River, and inspired the Native American legend of the Bridge of the Gods. As the river cut through slide debris, huge fans of gravel and sand spread downstream. Remnants of these gravelly fans form Pierce and Ives Islands. The spawning gravels used by chum salmon and cobble substrate that grows Columbia yellowcress at Pierce were originally deposited by the Columbia as it cut through the landslide.

Over the last several million years, as the modern Cascade Range rose, the powerful Columbia cut through the rising rock, and the Gorge was born. Well after the Gorge began forming, the climate of the Earth changed dramatically. Beginning about 2 million years ago, winter snows that fell in the mountains and plains of northern Europe and North America did not melt during the unusually cool summers. The accumulating snow eventually formed glaciers. One such glacier dammed the Clark Fork in northern Idaho to form Glacial Lake Missoula. The ice dam broke and reformed repeatedly, each time releasing tremendous volumes of water. On reaching the Columbia River Gorge, the flood waters attained elevations of at least 1,000 feet. When the floods reached the Steigerwald Lake Refuge area, they spread out across the Portland Basin. Much of Vancouver, Washington, and Portland, Oregon, are built on sand and gravel bars left by the floods. After the glaciers that once mantled the Cascade Range melted, the once deeply entrenched valley of the Columbia at and below Steigerwald Lake Refuge filled with sand and silt, forming the broad floodplain seen there today.

During the period of historic records, geological events in the Gorge have been less dramatic, but not without reminders of its unsettled past. Small landslides and debris flows occur frequently, including one at Dodson, Oregon, in 1996 that closed Interstate 84. Continued settling of the Bonneville Landslide has twice fractured a natural gas pipeline that crosses it. Before construction of flood control dams in the upper Columbia, spring floods were much larger, including the flood of record in 1894. This flood deposited a large mass of driftwood at Franz Lake Refuge, setting off the sequence of events that formed the lake.

Soils

Over the ages, slides and washes have transported soils and rock from the walls of the Gorge to the valley floor. This colluvium comprises the higher terraces and steeper slopes of the Gorge Refuges. The soils of the lower elevations of the Gorge Refuges are predominately alluvial in origin. Materials transported by the river settle out along the river's margin or into the floodplain. Before the construction of the many Columbia River dams, most of the acreage encompassed on the Refuges was subject to inundation by the seasonal freshets. Remnant channels cut by flood waters are still evident on the Gorge Refuges. Soil texture ranges from gently sloping silty soils to steep gradient gravelly soils. These soil textures and characteristics have been mapped and described by the Natural Resource Conservation Service in their Soil Survey of Skamania County Area, Washington, and Soil Survey of Clark County, Washington. The principle soil type of the Gorge Refuges is loam (7-27% clay particles, 28-50% silt, and less than 52% sand).

Climate

The predominant climate of western Washington is mild and rainy. In fall and winter, low pressure forms in the Gulf of Alaska with high pressure centers shifting to the south. Circulation of air around the low pressure in the north Pacific Ocean bring a prevailing flow of warm, moist, marine air

into western Washington. The Coast Range protects much of western Washington from severe winter storms moving inland from the ocean. A colder and drier continental air mass is typical for winters in the eastern portion of the State. The moist marine air mass of the west and cool continental air mass of the east are largely separated by the Cascade Range. The Columbia River Gorge functions as a low-elevation pass through the Cascade Range, allowing air exchange between the inland and coastal areas of the State. The convergence of these air masses result in highly variable and, at times, extreme weather. Winter winds generally blow from east to west, bringing gale force winds to the Gorge. The funneling of air masses through the Gorge has yielded winds of 80 miles per hour. The blend of moist marine air and cold continental air in the Gorge periodically produces snow and ice, even on the valley floor.

During the winter, clouds form over the Pacific Ocean and move inland on prevailing westerly winds. As these clouds encounter the Cascade Range, moisture condenses and falls as precipitation. Annual precipitation immediately west of the Cascade Range, near Pierce Refuge, is approximately 77.5 inches. In comparison, Portland located approximately 30 miles to the west, receives 38 inches of annual precipitation.

Late in spring, high pressure establishes over the northern Pacific Ocean bringing a prevailing flow of cool and comparatively dry air from a northwesterly direction. As the air moves inland, it becomes warmer and drier. As a result, a dry season begins late in spring and reaches a peak in midsummer. The drier air mass makes precipitation less likely, with only 20 percent of rainfall in the Gorge occurring from April to September. Summer winds tend to be more moderate and directed up the Columbia River between May and October.

Hydrology

The localized hydrology of the Gorge Refuges is dependent upon natural influences including climatic conditions, seeps, springs, and drainage within localized watersheds. The Hardy, Grenia, Indian Mary, and Gibbons Creeks watersheds all drain onto the Gorge Refuges. Quantity, timing, and quality of water transported by these watersheds are influenced by land use practices and development within each watershed.

Water Quality

Fish and wildlife in the lower Columbia River are exposed to a range of pollutants known to cause adverse health effects via contaminated water, sediments, and prey. In *The Health of the River*, the Bi-State Water Quality Program summarized results from a six-year study to assess the state of the lower Columbia River.[35] It found that fish-eating wildlife, specifically river otter, mink, and bald eagle, are being contaminated by man-made organic pollutants. These pollutants, especially dioxins and furans, DDE (a metabolic byproduct of DDT), and PCBs are found in a number of locations in the river at levels that may be harmful to wildlife.

When Gibbons Creek (Steigerwald Lake Refuge) was rerouted in 1992 a remnant

channel formed in the abandoned channel. This remnant channel serves as the receiving water body for wastewater from five industrial facilities, in addition to stormwater runoff from many more facilities. Since rerouting, the amount of water available for dilution of these discharges has been substantially reduced.

Water samples taken from the remnant channel in 1994 and 1995 exceeded Washington State's water quality criteria for pH, temperature, fecal coliform, turbidity, and dissolved oxygen. Samples taken from stormwater sewers feeding the remnant channel violated criteria for pH, hexavalent chromium, total chromium, copper, zinc, and arsenic. Organic compounds were detected at low levels in the remnant channel; volatile compounds were similar to those documented in groundwater beneath the nearby Burlington Environmental (BE) Washougal facility. Pentachlorophenol and several other phenolic compounds, nitrosamines, and phthalates were detected in trace amounts in the storm sewer, although no compounds exceeded EPA criteria for aquatic life effects. Metal concentrations in sediment samples taken from the lower channel were elevated for arsenic, chromium, copper, zinc, cadmium, and lead.[45]

The WDOE made several recommendations in 1996 to address the contamination in Gibbons Creek, including improving water quality in the stormwater runoff from the industrial park; monitoring to ensure compliance with permit limits and identify sources of zinc and arsenic; evaluating options for routing and treatment of the storm sewer system; and addressing contaminated groundwater beneath the BE site through the Resources Conservation and Recovery Act permit for that facility.

Although a significant amount of contaminated soil has been excavated beneath the BE site, groundwater monitoring reveals continued contamination from two industrial facilities discharging offsite.[33] The majority of the upper groundwater aquifer travels east and is intercepted by a utility trench where contaminated water can be collected and treated. Water bypassing the trench moves into the Steigerwald Lake Refuge, and contamination on the Refuge was indicated in one monitoring sample.

New discharge permit limits for chromium and copper went into effect for two wood-preserving facilities within an industrial park in 1996. To meet those limits, one wood-preserving company has rerouted its discharge from Gibbons Creek to the Columbia River and installed a high power diffuser, while the second wood treater has put resources into a new treatment facility with storage capacity.[2] Both facilities exceed permit limits for copper on occasion but are working with WDOE to prevent violations.

Gibbons Creek is currently on the Clean Water Act section 303(d) list as a water quality limited waterbody for fecal coliform bacteria based on WDOE data.[15] In addition to high fecal coliform bacteria counts, higher than normal levels of nutrients (phosphorus, nitrate), turbidity, and temperature were recorded.[15] The Service recorded similarly high water temperatures ($\geq$60°F) in the watershed during the summer of 1998 and 1999.[3] Non-point sources of

pollution in the watershed include urban runoff, leaking underground septic tanks, land development, and agricultural and silvicultural practices.

Water quality data for the Indian Mary (Franz Lake Refuge) and Hardy Creek (Pierce Refuge) watersheds is limited. The Forest Service assessed attributes of watersheds within the Columbia River Gorge National Scenic Area (Scenic Area) that can influence water quality. Hardy Creek and Gibbons Creek are among those watersheds on the Washington side of the Scenic Area with the highest road density, stream crossing density, and miles of road with slopes exceeding 50 percent. In contrast, Indian Mary Creek has a low road crossing density and the lowest number of miles of road exceeding 50 percent slope of Washington watersheds within the Scenic Area.[43] Hardy Creek watershed contains trails originating from Beacon Rock State Park. These trails may reduce water quality within Hardy Creek through runoff, erosion, soil disturbance, and vegetative loss. Over the past decade, Beacon Rock State Park and the Chinook Trail Association have implemented measures to reduce trail impacts within the Hardy Creek watershed.

Water quality in the Indian Mary Creek and Hardy Creek watersheds is afforded some protection through public ownership and land-use restrictions. The lower portion of the Indian Mary watershed is within the Scenic Area. Land adjoining Indian Mary Creek is largely within federal ownership. The Hardy Creek watershed is predominantly within the Scenic Area with only the headwaters outside the Scenic Area boundary. Approximately 92 percent of land adjoining Hardy Creek is in public ownership. Nearly half of the Gibbons Creek watershed is within the city limits of Washougal, Washington. Land ownership adjoining Gibbons Creek is predominately private with the exception of Service lands, City of Washougal property, and several tributary segments within the Scenic Area.[3]

Water from the Grenia Creek watershed (Pierce Refuge) is impounded behind a water control structure to form Pierce Lake. The water within Pierce Lake is periodically turbid, presumably the result of wind induced wave action stirring the fine sediments captured within the basin. Pierce Lake water spilling through the water control structure merges with Hardy Creek upstream of the majority of chum salmon spawning redds. At their confluence, water originating from Pierce Lake is often visually more turbid than water from the Hardy Creek watershed. Fine sediments introduced to the water column from Pierce Lake may be a threat to the viability of downstream chum redds.

Air Quality

The east winds that exemplify the Gorge winter weather pattern seasonally minimize the potential for reduced air quality standards at the Gorge Refuges. In summer and fall, air inversions and idle air masses are common to the valleys of southwest Washington and the Portland metropolitan area. These stagnant air masses can accumulate pollutants and emissions to unhealthy levels. These pollutants are largely generated by motor vehicles and industries in the Portland-Vancouver Air Quality Maintenance Area. During the

summer of 2002, Portland exceeded air quality standards considered safe for some groups on three days. These patterns are often improved by moderate westwardly breezes which disperse pollutants from the metropolitan areas up the Gorge. Air quality monitoring stations in the Scenic Area have identified ozone concentrations at or above the injury threshold for sensitive lichens. The Scenic Area has relatively poor visibility in comparison to 17 other locations in the northwest where visual quality is important to scenic values. Crown Point, Oregon, consistently ranks near the bottom for visibility.

Refuge Habitats and Associated Wildlife

Wetland Complex

Lower Columbia River wetlands are broadly characterized as tidally influenced riverine systems and further defined as wetland systems dominated by flowing water and dynamic hydrological processes. The Gorge Refuges contain some of the last remaining examples of riverine, lacustrine and palustrine wetland types currently found on the Columbia River (terms defined in Appendix A). These wetland complexes are influenced both by natural processes and by processes that have been highly altered by humans. For management and planning purposes, this CCP identifies four wetland types: riverine, open water, emergent, and wet meadow. Open water are lacustrine systems; emergent and wet meadow are palustrine sytems.[10] Wet meadow communities currently do not exist on the Gorge Refuges, as this community has been displaced by invasive reed canarygrass. Wetlands dominated by shrubs are classified as riparian scrub-shrub communities and are included in the description of riparian systems. The following describes the four wetland types at each of the Gorge Refuges.

Steigerwald Lake Refuge.

Early explorers and fur traders who passed through the Steigerwald Lake area often described it as a prairie. In 1805 and1806, Lewis and Clark mapped the area as "prairie." In his journal, Lewis described the diversity of trees and evergreen shrubs in the bottomlands and the "sand rush which are luxuriant and abundant in the river bottoms."

Over the following two decades, the bottomlands at Steigerwald Lake became known as the "Tea Prairie," perhaps because of the abundance of wild mint growing in the area. Land surveyor notes from 1856 described the river bottom as "rich prairie" that was "unfit for cultivation due to inundation." Early settlers attempted to farm the area, but annual spring flooding by the Columbia River and Gibbons Creek made farming difficult, if not impossible. Annual freshets persisted until the major dam building projects of the 1950s. The bottomlands were diked in 1966 and expulsion pumps were installed in preparation for the development of the Washougal Industrial Park at the western margin of Steigerwald Lake.

Looking east at the Steigerwald Lakebed. Photo USFWS.

A drainage ditch was dug through the middle of the lake basin to further drain the area, the cottonwood forest was reduced, and grazing reduced the shrub component within remnant riparian areas. Most of these changes occurred only within the past 30 to 40 years (Table 4-1).

In 1992, the U.S. Army Corps of Engineers (COE) constructed an elevated channel to transport the waters of Gibbons Creek from its inflow to the Refuge over Steigerwald Lake out to the Columbia River. This realignment reversed the natural westward outflow of Gibbons Creek to the east. Excavation of fill material for the dike formed a lake (Scaup Pond) where there were once several shallow seasonal ponds. The surface area of Scaup Pond is approximately 13 acres. The elevated channel begins at a flow control structure south of State Route 14. At this point, all flows up to 70 cfs are routed into the elevated channel. Flows exceeding 70 cfs are diverted into the original Gibbons Creek channel west of the elevated channel. At the time of construction, winter storms in excess of 100 cfs were calculated to be an infrequent occurrence.

Table 4-1. Historic change in wetland and riparian cover, Steigerwald Lake Refuge

Habitat Type	Acres (%)[1]		
	1956	1993	Net Change
Emergent Wetland[2]	432 (41%)	320[3] (31%)	-112 (-10%)
Riparian Forest	129 (12%)	47 (4%)	-82 (-8%)
Scrub-Shrub	90 (9%)	30 (3%)	-60 (-6%)

[1]Precent of Refuge area with this habitat type, excluding private lands within the approved Refuge boundary.
[2]Includes emergent, wet meadow, and open water areas.
[3]At 16 feet mean sea level (maximum operation pool elevation).

The elevated channel, plus two other dikes with water control structures on the Refuge, one west and one east of the channel, permit the Refuge to manage water levels within three wetland impoundments. For information on the location and operatio of these wetland impoundments, see the wetland management guidelines in Appendix M. Given the constraints imposed by adjacent private lands, the Refuge can manipulate water levels on only a fraction of the former wetland basin. Water elevation in Steigerwald Lake fluctuate between a seasonal low of about 10 feet to a maximum elevation of about 16 feet, providing approximately 322 acres of wetland habitat (Table 4-2). Because the topography of the

Steigerwald Lake basin is shallow, small increases in water elevation can produce substantial increases in wetland habitat area. Prior to construction of the Columbia River dike, and after the Bonneville Dam was completed, the spring freshet likely formed a 642-acre lake annually.

Table 4-2. Acres of potential wetland habitat at various elevations, Steigerwald Lake.

Water Elevation (feet)	Surface Area (acres)
9	0
10	3
12	67
14	224
16	322
18	401
20	489
22	642

Other wetlands at Steigerwald Lake Refuge include Redtail Lake and several isolated, perched wetlands (see Figure 4-2). Redtail Lake is filled and maintained by precipitation and potentially by ground water seepage from the Gibbons Creek channel. Water in the basin is typically perennial, however, during the summer months the lake may retreat to a very small pool (less than one acre). When fully recharged, the Redtail Lake basin covers up to 20 acres.

Franz Lake Refuge.

The wetland complex at Franz Lake Refuge includes permanently and seasonally flooded tidal basins, riverine wetlands, seasonally flooded non-tidal wetlands, and a number of permanent and seasonal springs. Franz Lake is fed by Indian Mary Creek and several springs, and empties into Arthur Lake on the west end. Arthur Lake also receives water from several springs and empties into the Columbia River to the west (Figure 4-3).

Water levels on Franz and Arthur Lakes in winter and spring are primarily determined by the elevation of the Columbia River, which is strongly influenced by releases from the Bonneville Dam. Beaver dams throughout the Refuge's wetland complex maintain water surface elevations in summer when Columbia River flows are at their lowest. Water levels in Franz and Arthur Lakes range from seven feet in August through October to 21 feet in April through June. Peak elevations are 30 feet. Arthur Lake ranges in size from more than 50 acres during high water to a small perennial stream in late summer. Franz Lake is relatively stable in size due to a large beaver dam at its outlet. There are approximately 130 acres of emergent wetland at this Refuge. Wetland vegetation includes willow, wapato (arrowhead), bulrush, other rushes, sedges, plantain, smartweed, and several mints (Figure 4-3). Reed canarygrass fields surrounding Franz and Arthur Lakes were not grazed for four years prior to acquisition by the Service in 1990. In 1992 Refuge staff experimented with a grazing program to remove the thick canarygrass growth to increase the plant diversity of the area.

Figure 4-2. Base vegetation: Stiegerwald Lake Refuge

Figure 4-3. Base vegetation: Franz Lake Refuge

Figure 4-4. Base vegetation: Pierce Refuge

Electric fences were installed and 70 cows were allowed to graze. The grazing program resulted in degradation of the riparian habitat, and grazing was eliminated at Franz Lake Refuge in 1996. Since that time, no active management of wet meadow vegetation has occurred at the Refuge.

The Refuge provides important wintering habitat for tundra swans; as many as 1,000 have been observed on Franz Lake.[39] Other common waterfowl include western Canada goose, mallard, northern pintail, gadwall, green-winged teal, northern shoveler, canvasback, ring-necked duck, and American wigeon. Cavity-nesting ducks, including wood duck, bufflehead and common merganser, have also been observed. The Refuge provides abundant habitat for wading birds such as great blue herons and rails, as well as songbirds that make use of grass/sedge meadows, cattail ponds, willow thickets, and riparian forests.

Pierce Refuge.

Wetlands at Pierce Refuge include permanently flooded basins (Pierce Lake and Lena's Lake), riverine wetlands (Hardy Creek, Columbia River), several seeps and springs, and numerous small intermittently flooded basins (Figure 4-4). Pierce Lake is the result of a dike and water control structure built across Grenia Creek in 1994 to replace an earlier structure that had failed. Grenia Creek, springs, and precipitation feed the lake, which is maintained as a semi-permanent wetland during summer. Periodically, the lake is drained in summer (1999, 2001, 2003) to remove invasive species, including carp, bullheads, and bullfrog tadpoles. Most of the lakebed when drained consists of mudflats with very little vegetation, possibly a result of the foraging activity of the carp population. At full pool, the surface acreage of the lake is about 10 acres.

Pierce Pond functions as a backwater to Pierce Lake that also receives periodic inflow from Grenia Creek during high water events. A gravel service road transects the wetland near the Refuge's east boundary where an open culvert allows Grenia Creek water to drain under the road and into a cottonwood-ash forest. From there, the drainage empties into an elongated depression that forms a seasonal wetland within Pierce Pond. When water depths in Pierce Lake exceed 4.5 feet, water can overflow into Pierce Pond to fill or supplement the basin. In June 2000, a water control structure was installed for improved water management capability. Water levels during the winter are held at 5.5 to 6.0 feet. This basin is managed as a seasonal wetland that at full capacity attains a surface area of two acres.

In 1999, a dike and water control structure were installed at the outlet of a small stream formed by precipitation and perennial flow from Domestic Springs. The structure is currently managed to maintain a semi-permanent wetland pond, which drains into Hardy Creek. Wetland benches are dominated by reed canarygrass; emergent vegetation grows along the shallow pond margins. The center of this wetland is too deep to support emergent vegetation. At managed pool levels, this wetland encompasses about 2 acres.

Lena's Lake was created prior to Refuge establishment by damming an unnamed creek entering a man-made basin through a railroad culvert. The dike was rebuilt and a new water control structure was installed in 1999. The elevated water control structure does not allow complete draw-down of the lake, limiting options for wetland management. Currently, the 1.6-acre basin is managed as a semi-permanent wetland; however, water depths, carp, and heavy sediment loads limit the growth of emergent and submergent vegetation.

Riparian Systems

Black cottonwood and Oregon ash are characteristic dominant tree species along the Columbia River, achieving maximum development west of the Columbia Gorge.[16] Nearly pure stands of black cottonwood occur on many of the islands and line the shores in this area, often in association with tall willow (up to 32 feet). Oregon ash increases in dominance on slightly higher sites protected by natural levees. Also included in this system are riparian scrub-shrub wetlands. These wetlands include areas dominated by woody vegetation less than 20 feet tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.[10] The native understory of these forests can include red alder, snowberry, red-osier dogwood, blackberry, and nettles. The approximate number of acres of riparian forest and riparian scrub-shrub vegetation are shown in Table 4-3.

Table 4-3. Estimated acres of riparian communities on the Gorge Refuges.

Refuge	Cottonwood - Ash Forest	Scrub-Shrub
Steigerwald Lake	47	30
Franz Lake	57	63
Pierce	115	7

Steigerwald Lake Refuge.
Riparian forest consists primarily of two disjunct stands: a 28-acre stand paralleling the lower portion of Gibbons Creek, and a 15-acre stand at Cottonwood Beach (Figure 4-2). Additional cottonwood-ash forest exists at Cottonwood Beach contiguous with the Refuge but not within Refuge jurisdiction. Small, isolated patches of cottonwood or willow comprise the remaining acres of riparian forest. No data are available on the canopy cover, shrub cover, or age-class distribution of these riparian stands.

Franz Lake Refuge.
The composition of riparian vegetation between State Route 14 and the Columbia River varies with elevation (Figure 4-3). Willows dominate lower elevations adjacent to Franz and Arthur Lakes, while at higher elevations within the floodplain (up to 30 feet) bottomland forests consist of Oregon ash and black cottonwood. Four cottonwoods average approximately 7 feet in diameter. These are near-record size cottonwood trees for the region. The understory is dominated by reed canarygrass in seasonally flooded sites and by nonnative Himalayan blackberry at higher elevations.

Riparian forest upper canopy cover is 49 percent, while the sub-canopy is 17 percent. Riparian scrub-shrub upper canopy cover is 18 percent and the subcanopy is 23 percent. The shrub cover is 35 percent in riparian forest and 8 percent in riparian scrub-shrub. Saplings that will presumably replace lost canopy trees only comprise 2 percent of the shrub layer. The paucity of saplings is primarily a result of past grazing practices and competitive exclusion by reed canary grass and nonnative blackberry.

Mature cottonwoods and conifers along the forested margins of the lakes provide nesting, perching, and roosting opportunities for songbirds and raptors. Raptor species documented at Franz Lake include bald eagle, osprey, red-tailed hawk, and American kestrel. A bald eagle nest was located along the Columbia River at Franz Lake and was used annually from 1998 to 2000.

Pierce Refuge.
Land clearing and cattle grazing prior to Refuge establishment significantly reduced forest cover. Cattle grazing significantly impacted the subcanopy layer. Between 1935 and 1993, approximately 80 acres of cottonwood-ash forest were cleared. Land clearing prior to 1935 reduced bottomland forest by at least this much again.

The majority of riparian forest on Pierce Refuge occurs between Hardy Creek and the Columbia River (Figure 4-4). Riparian forest south and west of Pierce Lake is a mix of cottonwood and Oregon ash, with cottonwood saplings dominating the understory. East of Pierce Lake, the riparian forest is dominated by Oregon ash with an understory of snowberry. Canopy cover is about 68 percent. Cattle grazing was removed from the Refuge in 1996, and native shrubs have increased in riparian areas. However, nonnative blackberry is beginning to invade these areas.

Riparian scrub-shrub vegetation is largely limited to streamsides. Supplemental plantings by the Service and the Natural Resource Conservation Service in 1986 and 1993 augmented natural regeneration of shrub cover along Hardy Creek. No data are available on the percent cover in riparian scrub-shrub vegetation.

Columbia River Shoreline Habitats

Steigerwald Lake.
The Columbia River shoreline habitats of Steigerwald Lake Refuge consist of areas that slope to the water's edge as well as areas of abrupt cutbanks. While erosion appears to be a problem along much of the shoreline, studies have not been conducted to evaluate the issue.

Franz Lake.
Aerial photos taken in 1930, 1948, and 1997 reveal deterioration of the riverbank at Franz Lake Refuge. The average rate of shoreline erosion has been variable since 1930. However, erosion may be two to three feet during some years. Bank erosion along the shoreline in this reach appears to be the result of rapid changes in water surface elevation (due to operations of Bonneville Dam and tidal influences), rather than erosional shear from high velocity flows in the river. Plant cover in the area is does not appear to provide adequate protection from erosion. If the rate of erosion continues to

exceed the rate of sediment deposition, the Columbia River may eventually overtop the bank creating a seasonally active side channel in the area occupied by Franz Lake. Presumably, hydrologic conditions in this side channel would promote sedimentation resulting in eventual filling of the lakebed.

Pierce Refuge.
Unlike the sandy, highly eroded shoreline found at Franz Lake and Steigerwald Lake Refuges, the Columbia River shoreline at Pierce Refuge is characterized by a coarse substrate of cobble and gravels. From Pierce Refuge, these rocky shores extend about two miles east to Bonneville Dam and about three miles west to the town of Skamania. These five miles are all that remain of what was a much more extensive Columbia River cobble/gravel shoreline, now inundated by the Bonneville Dam. These sparsely vegetated, rocky shores provide habitat for a rare plant species, the persistent sepal or Columbia yellowcress. The habitat requirements for this State Threatened plant are described in this CCP/EA in the section titled Special Status Species. Cobble zones within remaining yellowcress habitat are further threatened by vegetation encroachment and the hydrologic alterations imposed by the operation of Columbia River dams. Dams alter the frequency, timing, severity, and duration of annual flooding events. Spring floods are now less severe with water released over longer periods of time. This alteration of the flood regime has allowed sediments to accumulate in cobble habitats. This sedimentation and tempering of flood events has allowed vegetation to encroach and compete with Columbia yellowcress for light, nutrients, space, and water.

Grasslands

Grasslands on the Gorge Refuges consist primarily of nonnative, introduced grasses initially planted for agricultural purposes (e.g., cattle forage and hay crops). There are no known intact populations of native grasses or prairie forbs remaining on these Refuges, although native forbs and grasses may comprise a small component of the grassland community. Refuge grasslands consist of "managed fields" and "old fields." The former are managed to provide winter browse for Canada geese. Old fields receive only limited weed control. Weed control also occurs within managed fields. Grassland management on each Refuge is described below.

Steigerwald Lake Refuge.
The Steigerwald Lake basin has a long history of grazing prior to Refuge establishment. When acquired, grazing occurred on most of the Refuge lands, with 210 head of cattle grazing on approximately 682 acres. Grazing was reduced to 150 cattle by 1996 due to a variety of wildlife and habitat concerns. In 1996, a Service Habitat Review Team recommended additional changes to the grazing program, which prompted the cooperator to withdraw his grazing privileges.

The current cooperator operates under a three-year cooperative land management agreement, which will expire in 2006. The CCP/EA contains a Compatibility Determination which explains the haying and grazing program in some detail (Appendix K). The Service controls weeds and mows fields not under the cooperative agreement to provide winter forage for

Canada geese. In recent years, significant progress has been made in controlling thistle. Winter surveys of Canada geese have identified a number of fields with minimum foraging use; mowing of those fields has been discontinued and the vegetation is left undisturbed to provide habitat for nesting birds and other wildlife. The Refuge currently consists of 293 acres of managed fields and 215 acres of unmanaged fields (Figure 4-2).

Winter surveys conducted at Steigerwald Lake from 1975 to 1987, documented up to 450 Canada geese in the area.[6] The predominant subspecies of Canada geese observed in 1987, were western and Taverner's, with noteworthy observations of three dusky Canada geese and 15 cackling Canada geese. During the early 1990s, cackling Canada geese largely shifted wintering range from California's Central Valley to western Oregon and southwestern Washington.[36] During this same period, the population of cackling Canada geese was also increasing. Regionally, the culmination of these factors resulted in a significant increase in wintering cackling Canada geese. At Steigerwald Lake Refuge the average number of wintering geese from 1998 to 2003 was 857 with high counts of over 3,000 (Table 4-4). The flocks were composed of approximately 77 percent cackling Canada geese.

From 1998 to 2003, dusky Canada geese were observed on six different occasions at Steigerwald Lake Refuge. Most of these observations were in February and March, 1999, and were 10 or fewer birds. Although dusky Canada geese have been sporadically observed at Steigerwald Lake Refuge, this area appears to be located outside the subspecies' primary wintering range.

Table 4-4. Canada geese surveys, 1998 through 2003, Steigerwald Lake Refuge.

Year	Average Population	Maximum Population
1998/99	1485	4004
1999/00	706	1802
2000/01	491	2637
2001/02	584	3388
2002/03	1020	1943

Franz Lake Refuge.
There are 54 acres of scattered old fields on this Refuge and no managed fields (Figure 4-3).

Pierce Refuge.
Prior to and after acquisition, much of the Pierce Refuge was grazed by a lessee with a long term agreement and an additional 10-year option. The lessee chose not to renew the option. Due to severe overgrazing in woodlands and the fact that grazing was not consistent with the goals and objectives of the Refuge, the program was terminated in 1996.

There are approximately 36 acres of managed field on Pierce Refuge (Figure 4-4). Grassland management currently consists of mowing and weed control, using chemical, mechanical, and biological methods. Winter goose use has declined from about 300 geese in the 1990s to only a few sightings of small (less than 25 geese) flocks. This decline coincided with a

reduction in the amount of grassland habitat maintained in goose browse. The North Bonneville field has not been mowed since 2000 due to a lack of staff.

Oak Woodland and Oak Savanna

Although oak habitats can be broadly defined as oak woodland and oak savanna, considerable gradation occurs naturally between these two types. Oak savannas are oak-dominated stands described structurally as oak or mixed oak stands with total canopy coverage less than 25 percent with oaks contributing 50 percent of the canopy coverage present.[26] Conifers may comprise less than 25 percent of the crown cover. Other broadleaf trees (e.g., ash, maple, and madrone) may be co-dominant with oak. Typical native grass and forb species associated with oak savanna include Roemer's fescue, red fescue, California oatgrass, western bittercress, American vetch, western wood strawberry, spring beauty, chickweed , balsamroot, and lupine. Oak savanna does not currently exist on the Gorge Refuges.

Oak woodlands are defined as pure oak or a mix of oak and conifer associations with oak constituting at least 25 percent of the crown cover. Stands may be co-dominated by other broadleaf trees, as well. The understory is characteristically dominated by native shrubs such as ocean spray, oval-leafed viburnum, California hazelnut, serviceberry, common snowberry, trailing blackberry, Indian plum, poison oak, nootka rose, and tall Oregon grape. Many species of flora and fauna associated with this unique system are of conservation concern due to declines in population, local extirpation, or close associations with this declining habitat.[26] Three key conservation targets for the Gorge Refuges that require oak habitats are Bewick's wren, western pond turtle, and white-breasted nuthatch.

Oak woodlands and oak savannas are among the most imperiled ecosystems in western Washington.[34] The lack of a natural fire regime has allowed conifers to dominate in Oregon white oak communities. Oak regeneration seems to be limited by the lack of a fire regime and the presence of a dense monotypic understory of nonnative Himalayan blackberry which occasionally exceed seven feet tall. Oaks are slow growing, have a long maturation time, and cannot outgrow nonnative blackberry or compete for light from within a dense understory of this species.

<u>Steigerwald Lake Refuge.</u>
A small, isolated patch of oaks with a dense understory of nonnative Himalayan blackberry exists near the former Stevenson homestead. This one-acre stand is a relict from a larger woodland that was cleared for construction of State Route 14.[6] Approximately 14 acres of scattered oaks exist south of the railroad (Figure 4-2). North of the railroad, approximately 26 acres of mixed oak, maple, and conifers exists.

In 2003, the Washington State Department of Natural Resources designated the 976-acre Washougal Oaks Natural Resource Conservation Area and Natural Area Preserve. Oak woodlands at Steigerwald Lake Refuge represent the southwest edge of the designated area. This woodland is the largest occurrence of the Oregon white

oak/oval-leaved viburnum - poison oak community in western Washington. This is a globally critically imperiled community type because of the small number of occurrences, small global range, and high threats.

All existing oak habitat at Steigerwald Lake Refuge occurs on Hillsboro silt loams and Lauren gravelly loams. These soils, which are ideal for Oregon white oak, are the predominant soil type within a 125-acre area between Steigerwald Lake and the Evergreen Highway.[36] Oaks likely dominated this area prior to development.

Franz Lake Refuge.
Several acres of mixed oak/conifers occur in a very narrow band above the floodplain and below the railroad tracks (Figure 4-3). Soils conducive for oaks within the Refuge boundary are currently wooded and relatively steep, limiting opportunities for the expansion of oak habitat.

Pierce Refuge.
Starting in 1955, the Pierce family cleared trees and brush to increase the amount of pasture available for cattle on their ranch.[38] The amount of oak habitat that was cleared cannot be accurately determined; however, evidence from the remaining oak habitat and interpretation of 1935 aerial photos suggest that at least 26 acres of oak woodlands formerly existed in the north-central portion of the Refuge. Oak regeneration in this area was presumably limited by grazing practices from 1955 to 1996.

Prior to extensive damming of the Columbia River, the preference for grazing areas above the floodplain may have inadvertently targeted oak habitats for pasture conversion. The remaining oak habitat at Pierce Refuge totals approximately 27 acres (Figure 4-4) and occurs in both Bonneville stony sandy loam and Pilchuck very sandy loam soils. The Bonneville series is suitable soil for Oregon white oak production.[37] The suitability of the Pilchuck for oaks is unknown.

Invasive Species

A wide-variety of nonnative plants and animals infest the Gorge Refuges. Given their location on a major river corridor, these Refuges are at tremendous risk for additional invasions by potentially damaging nonnative species, such as mitten crabs, zebra mussels, and hydrilla. The following describes the existing invasive species of primary concern to the Refuges.

Birds

Nonnative bird species occurring on the Gorge Refuges include house sparrow, rock dove, and European starling. House sparrows and starlings displace native cavity-nesting birds.

House sparrows are associated with the spread of human diseases and may be a vector in the transmission of West Nile Virus.[30] Control of nonnative birds has not been conducted on the Gorge Refuges.

Mammals

Nutria are rarely seen at Pierce and Franz Lake Refuges and occasionally seen at Steigerwald Lake Refuge. Nutria can

The light tops of the invasive reed canarygrass dominate this view of vegetation around Domestic Pond. Photo USFWS.

negatively impact wetland impoundments by digging tunnels into levees. However, nutria do not currently pose a management problem for the Gorge Refuges.

Reptiles and Amphibians

Bullfrogs were introduced to the Pacific Northwest in the 1920s or 1930s to be raised as food. Bullfrogs prey on native amphibians, turtle hatchlings, and even ducklings. Bullfrogs are removed from Pierce Lake to support the establishment of a western pond turtle population at Pierce Refuge. The lake is lowered to minimum pool on alternate years and bullfrog tadpoles are gathered and removed from the basin.

Fish

Nonnative fish are abundant within some waterways of the Gorge Refuges. Carp, which are widespread in the lower Columbia River, consume vegetation and invertebrates, compete with native wildlife for food, and degrade water quality by increasing turbidity.[46] To counteract these impacts, fish screens have been placed on the Pierce Lake water control structure and the lake is periodically drawn down to remove carp and other nonnatives from the lakebed.

Plants

The most abundant invasive plant found on the Gorge Refuges is reed canarygrass. Based on interpretation of aerial photography, it covers approximately 406 acres of the Refuges (see Figures 4-2, 4-3, and 4-4). Efforts to reduce its dominance in wetlands using flooding and tillage have been largely ineffective.

Himalayan blackberry is another pervasive nonnative plant found on the Gorge Refuges. Control efforts have focused on preventing nonnative blackberry from infesting grasslands that are managed for Canada geese. In 2003, Himalayan blackberry was mechanically cut along a section of lower Gibbons Creek. The site was sprayed with herbicides to prevent reinfestation, the ground was tilled, and the site was seeded to native grasses.

Japanese knotweed was recently (2000) found growing along Hardy Creek at Pierce Refuge. Starting in 2001, knotweeds downstream of State Route 14 were injected with herbicide and left standing. Follow-up treatments reduced knotweed from numerous dense patches to isolated individual plants or clusters.

Indigo bush appears to be increasing along the Columbia River shoreline. The Nature Conservancy,s efforts to manually remove indigo bush plants within areas supporting

Columbia yellowcress have not been effective. They plan to experiment with herbicide treatments on property next to Pierce Refuge.

Several noxious weeds occur on the Gorge Refuges. Canada thistle is common in managed fields at Steigerwald Lake and Pierce Refuges. Suppression has involved mowing, herbicide application, and biological controls. Poison hemlock and tansy ragwort are relatively uncommon noxious weeds on the Refuges.

Federally- and State-Listed Species

Birds

The bald eagle is the only federally listed bird known to occur on the Refuges. Additional special status bird species are listed in Table 4-6. Birds of Conservation Concern (BCC) have been identified by the Service as species likely to become candidates for listing under the Endangered Species Act.[41]

Peregrine Falcon.
Peregrine falcons nest in the Columbia River Gorge. An active aerie is located adjacent to Pierce Refuge. Peregrine falcons may utilize the Refuges throughout the year but occur more frequently from fall through spring, as migrants move into the area to hunt for waterfowl and other prey.

Sandhill Crane.
Nine cranes were observed landing along the Columbia River adjacent to Pierce Refuge on 19 September 2001. It is believed that these individuals belonged to the Washington breeding population. There are no other recent documented occurrences of sandhill cranes in this part of the Gorge. Migrant and wintering sandhill cranes are occasionally observed foraging in fields and wetland edges of Steigerwald Lake Refuge.

Bald Eagle.
Approximately eight to ten non-nesting bald eagles have been documented utilizing areas adjacent to Franz Lake Refuge in winter.[39] Cottonwoods and Douglas-firs provide perch sites on the Refuges. One active bald eagle nest was present between the Columbia River and Franz Lake from 1998 to 2000, but nesting activity has not been observed since the summer of 2000. The pair relocated to Skamania Island and continue to forage at the Refuge. Bald eagles are observed occasionally year-round at Pierce and Steigerwald Lake Refuges. Shoreline trees provide perches for hunting and roosting. Summer populations are comprised of nearby nesting pairs and a few non-breeding subadults. Numbers may increase in the fall and winter as migrant birds congregate to feed on salmon and waterfowl.

Northern Spotted Owl.
Spotted owls have not been documented on the Refuges; however, apparently suitable habitat occurs within the Indian Mary Creek watershed. Critical Habitat for the species occurs in Oregon directly across the Columbia River from Franz Lake and Pierce Refuges.

Table 4-5. Special status species of birds, Gorge Refuges.

Name	Federal Status	State Status	Related Habitats	Refuge Where Present (if any)	Comments
Accipiter gentilis (northern goshawk)	BCC	C	mature coniferous forests	ALL	Clark and Skamania County records
Chaetura vauxi (Vaux's swift)		C	grassland and savanna	**ALL**	seasonal migrant on all Refuges
Coccyzus americanus (yellow-billed cuckoo)	BCC, C	C	large deciduous woodlands		formerly nested in western Washington
Contopus cooperi (olive-sided flycatcher)	BCC		conifer forest	**FLR**	seasonal migrant
Dryocopus pileatus (pileated woodpecker)		C	riparian and conifer forest	**ALL**	probable nester on all Refuges
Falco peregrinus (peregrine falcon)	BCC	E	wetland and cliffs	**ALL**	nesting adjacent to PR
Grus canadensis (sandhill crane)		E	wetland, agricultural fields and grasslands	**PR, SLR**	seasonal migrant
Haliaeetus leucocephalus (bald eagle)	T	T	wetland, grassland, and forest bordering rivers	**ALL**	wintering ALL, FLR nest 1998-2000
Melanerpes lewis (Lewis's woodpecker)	BCC		mixed savanna, large conifers, and snags	**SLR**	recently observed near SLR
Progne subis (purple martin)		C	open water, snag, and cavities	**ALL**	FLR and SLR nesting, observed on PR
Selasphorus rufus (rufous hummingbird)	BCC		conifer and deciduous forests	**ALL**	nesting on all Refuges
Sitta carolinensis aculeata (slender billed, white-breasted nuthatch)		C	oak savanna	**SLR, PR**	Heard on PR, subspecies unknown
Strix occidentalis (spotted owl)	T	E	mature conifer	FLR	FLR may have suitable habitat

Key to Codes: E = Endangered, T = Threatened, C = Candidate, S = Sensitive, BCC = Birds of Conservation Concern, FLR = Franz Lake Refuge, PR = Pierce Refuge, SLR = Steigerwald Lake Refuge, ALL = All Gorge Refuges, Refuge Where Present: **Bold Text** = known to occur, plain text = potential to occur

Mammals

No federal or state listed mammals are known to occur on the Refuges. However, these Refuges have not been fully inventoried, particularly for bats or bat roosts. The Refuges provide potentially suitable habitat for several species of state listed mammals (Table 4-7).

Western Gray Squirrel.

The western gray squirrel occurs primarily east of Pierce Refuge in disjunct populations along the eastern slope of the Cascade

Range. This species is found in stands of Oregon white oak or mixed stands of oak and ponderosa pine (east side of Cascade Range) and Douglas-fir (west side of Cascade Range).[24] Steigerwald Lake and Pierce Refuges may provide suitable habitat for this species.

Table 4-6. Special status species of mammals, Gorge Refuges.

Name	Federal Status	State Status	Related Habitat	Refuge Where Present (if any)	Comments
Corynorhinuys townsendii townsendii (Pacific Townsend's big-eared bat)		C	low to mid-elevation forest types	ALL	Refuges are within known range
Sciurus griseus (western gray squirrel)		T	low elevation pure broadleaf deciduous or mixed with coniferous		All Refuges are in historic range, with PR nearest to current range
Thomomys talpoides douglasii (brush prairie pocket gopher)		C	pasture, grassland and cultivated fields	SLR	
Microtus canicaudus (gray-tailed vole)		C	pasture, agricultural fields, grasslands	SLR	

Key to Codes: E = Endangered, T = Threatened, C = Candidate, S = Sensitive, SC = Species of Concern, FLR = Franz Lake Refuge, PR = Pierce Refuge, SLR = Steigerwald Lake Refuge, ALL = All Gorge Refuges
Refuge Where Present: **Bold Text** = known to occur, plain text = potential to occur

Reptiles and Amphibians

Several state listed species of reptiles and amphibians are known to occur on the Refuges (Table 4-8).

Western Pond Turtle.

The western pond turtle has been extirpated from most of its range within Washington, and it currently exists in only three populations within the Columbia River Gorge. One of these populations is located on Pierce Refuge. This population was re-established through the release of 189 juvenile turtles between 2000 and 2003. Additional releases are anticipated until the species recovery goal is met.

Western pond turtles are mostly aquatic from April through September. The turtles forage in freshwater ponds, and are sometimes found in rivers and lakes. They feed on small invertebrates, aquatic vegetation, and sometimes scavenge carrion. Turtles usually begin to move out of the ponds to overwinter in upland habitats in August and September, although movement upland may occur as late as early November. Turtles that overwinter in the water are stationary for extended periods. Upland turtles begin moving back to ponds in March as weather warms up, with most turtles arriving in wetlands by the end of May.[20,21]

Pond turtle trapping shows a survival rate of 90.7 percent at Pierce Refuge. The mean weight gain for Pierce pond turtles over three years was 80% with an average annual weight gain of 20.4 grams per year during the first three years of the release.[44] This compares favorably with juvenile pond turtle growth at other sites, suggesting the head-start turtles released at Pierce are doing well.

Table 4-7. Special status reptiles and amphibians species, Gorge Refuges.

Name	Federal Status	State Status	Related Habitat	Refuge Where Present (if any)	Comments
Bufo boreas (western toad)		C	lakes, ponds, and river backwater for breeding, otherwise, largely terrestrial	**PR, FLR**	
Clemmys marmorata (western pond turtle)		E	marshes, sloughs, slow-moving creeks or rivers and adjacent uplands	**PR**	reintroduced population
Plethodon larselli (Larch Mountain salamander)		S	talus slopes with dense overstory of trees	ALL	known occurrences in vicinity
Rhyacotriton cascadae (Cascade torrent salamander)		SC	springs, seeps, headwater streams	**FLR**	

Key to Codes: E = Endangered, T = Threatened, C = Candidate, S = Sensitive, SC = Species of Concern, FLR = Franz Lake Refuge, PR = Pierce Refuge, SLR = Steigerwald Lake Refuge, ALL = All Gorge Refuges
Refuge Where Present: **Bold Text =** known to occur, plain text = potential to occur

Fishes

The Refuges provide spawning and rearing habitat for federal and state listed species of fish (Table 4-9). Because the three Refuges are located along the lower Columbia River, individuals of additional listed and candidate anadromous fish populations and evolutionary significant units (ESUs) from upstream areas of the Columbia River basin may be present in the Columbia River adjacent to the Refuges or in waters of the Refuges at certain times of the year. An ESU is a distinct population segment which is substantially reproductively isolated and represents an important component in the evolutionary legacy of the biological species. Prompted by recent court decisions, the National Oceanic and Atmospheric Administration-Fisheries (NOAA-Fisheries) announced that it would reconsider its designation of critical habitat for 19 ESUs of west coast salmon and steelhead. The final ruling is expected by January 2005. If any of the Refuges' salmon bearing streams are again designated as critical habitat, the Service does not anticipate that this designation would negatively effect any actions proposed in this CCP. However, the listing would require additional regulatory review of the proposed activities.

Chum Salmon.

Formerly, the annual chum salmon commercial catch exceeded eight million pounds in the lower Columbia River. Today, Hardy Creek on Pierce Refuge hosts one of the last chum salmon runs still existing within the Columbia River ESU. All available chum salmon spawning habitat in Hardy Creek is within the Refuge boundary. Most chum salmon spawning occurs below the bridge (constructed from a railroad flat car) on Hardy Creek within the lower reach of the watershed and is associated with spring seeps along the shoreline. The highest number of spawning chum recorded between 1997 and 2003 was 835 in 2001. The lowest number of spawning chum (37) was recorded in 2000.

In response to the limited chum spawning habitat, the Service's Columbia River Fisheries Program Office (CRFPO) constructed an artificial spawning channel. To date, chum salmon have not used the spawning channel. Future design modifications may be implemented to improve channel ingress, upwelling current characteristics, channel gradient, and to secure supplemental water sources.

At Steigerwald Lake, chum salmon were documented within the Gibbons Creek watershed prior to Refuge establishment. With construction of the Columbia River flood protection levee in 1966, chum were excluded from the watershed. Chum salmon apparently are unable to negotiate the fish ladder constructed to facilitate fish passage into Gibbons Creek. Chum salmon are not currently known to utilize Franz Lake Refuge. Chum salmon are expected to occur in the vicinity of Franz Lake and Steigerwald Lake Refuges within the mainstem Columbia River.

Coho Salmon.

Spawning adult and migrating smolt coho salmon have been found in small numbers in Gibbons Creek on Steigerwald Lake Refuge in surveys conducted between 1996 and 2003. Surveys of Franz and Arthur Lakes and their tributaries in 1996 and 1997 found juvenile coho salmon to be the most abundant salmonid in the wetland system. The adults likely spawn in nearby Goodbear and Archer Creeks, then juveniles move into Franz Lake during high water events. The juvenile coho smolts rear in the cooler waters in the Poacher Springs area of Franz Lake during the warm summer months. Small numbers of coho spawn in Hardy Creek. Coho produced on the Refuges would belong to the Lower Columbia River/Southwest Washington ESU.

Steelhead.

Steelhead spawning within the Gorge and observed during Refuge surveys are designated as the Lower Columbia River ESU. All naturally spawned steelhead are protected in the lower Columbia River and its tributaries upstream to Hood River, Oregon. The Upper Columbia River, Middle Columbia River, and Snake River Basin ESUs are known to migrate in the Columbia River past the Refuges, but have not been collected during on Refuge fish surveys. Surveys in 1996 and 1997 on Arthur and Franz Lakes and their tributaries identified the presence of steelhead smolts. Studies have not been conducted to discern

the origins of these smolts. Surveys at Pierce Refuge have documented steelhead spawning within the Hardy Creek watershed. At Steigerwald Lake Refuge, steelhead spawn within Gibbons Creek and its tributaries. On all the Refuges, both adult and juvenile steelhead may be present year-round within the Columbia River, its tributaries, and adjoining aquatic habitats.

Chinook Salmon.

Lower Columbia River chinook salmon is the only ESU likely to be found using refuge waters. Other ESUs migrate in the Columbia River with some potential to occur within Refuge waters including Snake River fall-run, Snake River spring/summer-run, and Upper Columbia River spring-run ESUs. Monitoring has not confirmed the presence of these mainstem ESUs within the Refuges. All naturally spawned chinook are protected in the lower Columbia River and its tributaries to Hood River, Oregon. Surveys of Arthur and Franz Lakes and their tributaries conducted in 1996 and 1997, found juvenile fall chinook in the spring and early summer months utilizing these areas for off-channel rearing. Surveys at Pierce Refuge have identified chinook salmon within the lower Hardy Creek watershed. At Franz Lake and Pierce Refuges both adult and juvenile chinook may be present at various times along the Columbia River, its tributaries, and adjoining aquatic habitats. At Steigerwald Lake, chinook salmon were documented within the Gibbons Creek watershed prior to the establishment of the Refuge. With the construction of the Columbia River flood protection levee in 1966, salmonids were largely excluded from the watershed by the dike and associated water control infrastructure. Despite subsequent modifications to facilitate fish passage, chinook salmon remain absent from the Gibbons Creek watershed. Chinook habitat at Steigerwald Lake is currently limited to portions of the Columbia River adjacent to the Refuge.

Sockeye Salmon.

The Snake River ESU is known to migrate in the Columbia River past the Gorge Refuges, but surveys have not indicated any use in Refuge waters.

Bull Trout.

No bull trout have been identified within Refuge watersheds; however, proposed critical habitat is found on each Refuge. Migratory bull trout moving within the Columbia River, have been identified in the area of Bonneville Dam; therefore, bull trout could be present in the vicinity of Pierce and Franz Lake Refuges throughout the year.

Pacific, River, and Western Brook Lamprey.

Pacific, river, and western brook lamprey may be found in the lower Columbia River at different times throughout the year. The river lamprey is parasitic as an adult but virtually identical to the non-parasitic western brook lamprey as a juvenile. The river lamprey has not been identified in the Columbia River system since 1980 and is not known to occur on the Refuges. Pacific and western brook lamprey have been identified on Steigerwald Lake Refuge, while the latter has also been identified on Pierce Refuge. The Service has received a petition (January 2003) to protect the four west coast lamprey species under the ESA.[29]

Table 4-8. Special status species of fish, Gorge Refuges.

Name	Federal Status	State Status	Refuge Where Present (if any)	Comments
Oncorhynchus keta (chum salmon - Columbia River ESU)	T	C	**PR**	SLR used prior to 1965
Oncorhynchus kisutch (coho salmon - Lower Columbia River/Southwest Washington ESU)	C		**ALL**	
Oncorhynchus mykiss (steelhead trout - Lower Columbia River ESU)	T	C	**ALL**	
Oncorhynchus tshawytscha (chinook salmon - Lower Columbia River ESU)	T	C	**FLR, PR**	SLR used prior to 1965
Salvelinus confluentus (bull trout)	T	SC	ALL	Clark and Skamania County records, use of Refuges unlikely
Key to Codes: E = Endangered, T = Threatened, C = Candidate, S = Sensitive, SC = Species of Concern, FLR = Franz Lake Refuge, PR = Pierce Refuge, SLR = Steigerwald Lake Refuge, ALL = All Gorge Refuges Refuge Where Present: **Bold Text** = known to occur, plain text = potential to occur				

Plants

Columbia yellowcress is the only listed plant known to occur on the Gorge Refuges (Table 4-10). The Gorge Refuges are within the historic range of six other special status plants, and potentially suitable habitat for these species may occur on one or more of the Refuges.

Water Howellia.

Several remnant populations of water howellia occur in the Columbia Basin and Puget lowlands. There are no known occurrences of water howellia on the Gorge Refuges; however, current plant inventories are insufficient to confirm its absence. The nearest known population is at the Ridgefield National Wildlife Refuge in Clark County.

Bradshaw's Lomatium.

This perennial forb was formerly common in native prairies of the Willamette Valley and Puget Trough and likely occurred on or in the vicinity of Steigerwald Lake. Bradshaw's lomatium reproduces only by seed which germinates soon after falling from the flower; therefore, seed persistence in the soil is low. Restoration of historic wet meadow or prairie habitat should benefit this species.

Barrett's Beardtongue.

This perennial plant is an endemic plant to the Columbia River Gorge. Most records are from Klickitat County, Washington. In Washington, the species typically grows in crevices in basalt cliff faces, on ledges of rock outcrops, and within open talus. Occurrences are often low elevation within rocky well drained substrate of basaltic

origin, with little soil development. There are no known occurrences of Barrett's beardtongue on the Gorge Refuges.

Threats to Barrett's beardtongue include quarrying, timber harvest, and hydrological changes that may alter the microclimates that support this species. Road maintenance and herbicide pose a threat to several populations occurring along well drained road sides. Recreational uses such as hiking and rock climbing may pose localized threats to populations.

Columbia Yellowcress.

Columbia yellowcress in the lower Columbia River occupies cobblestone shorelines where vegetation is sparse.[18] Populations below Bonneville Dam occur on or near Pierce Island, Ives Island, Hamilton Island, Pierce Refuge, Beacon Rock, the mouth of McCord Creek, and the confluence of the Sandy River. Most of these populations are relatively small, typically with fewer than 500 individuals and sometimes only one or two plants.[17] A survey of suitable habitat at Pierce Refuge conducted in 1992 found 300 to 500 stems. Since 1996, the population at Pierce Refuge has expanded from Hamilton Creek to much of the Columbia River shoreline of the Refuge and is currently the heartiest and most abundant known population in the Columbia River watershed.[14]

Volunteers with The Nature Conservancy (TNC) have conducted surveys at Pierce Refuge, Ives Island, and Pierce Island annually since 1991. In addition, TNC has provided weed control by pulling and cutting indigo-bush, an aggressive shrub which grows in the same gravelly substrate used by Columbia yellowcress.

Pale Blue-eyed Grass.

This endemic perennial plant is only known in Klickitat, Skamania, and Yakima counties. There are no known occurrences of pale blue-eyed grass on the Gorge Refuges; however, current plant inventories are insufficient to confirm its absence. The species occurs in low to mid-elevation meadows and small openings. Suitable sites typically retain snow or water in winter and spring.

Table 4-9. Special status species of plants, Gorge Refuges.

Name	Federal Status	State Status	Habitat Requirements	Refuge Where Present (if any)	Comments
Aster curtus (white-top aster)		S	valley grassland		Known only from historic Skamania County records
Cimicifuga elata (tall bugbane)		S	moist shady forests at lower elevations	ALL	Occurs in Clark and Skamania Counties
Howellia aquatica water howellia	T	T	vernal pools and seasonal ponds	All	Occurs in Clark County
Lomatium bradshawii (Bradshaw's lomatium)	E	E	moist meadows and wet prairie	SLR	Occurs in Clark County
Penstemon barrettiae (Barrett's beardtongue)		T	talus, cliff faces, ledges, outcrops	FLR, PR	Occurs in Skamania County
Rorippa columbiae (Columbia yellowcress)		T	Columbia River shoreline	**PR**	Occurs in Skamania County
Sisyrinchium sarmentosum (pale blue-eyed grass)		T	low to mid-elevation moist forest and meadows	FLR, PR	Occurs in Skamania County

Key to Codes: E = Endangered, T = Threatened, C = Candidate, S = Sensitive, SC = Species of Concern, FLR = Franz Lake Refuge, PR = Pierce Refuge, SLR = Steigerwald Lake Refuge, ALL = All Gorge Refuges
Refuge Where Present: **Bold Text =** known to occur, plain text = potential to occur

Refuge Public Use Facilities, Activities And Programs

The Refuges are not officially open to public use, although occasional special events and educational activities occur at Steigerwald Lake and Pierce Refuges. Additionally, the Columbia River Dike Trail (Dike Trail) provides access to Steigerwald Lake Refuge along its southern boundary.

Steigerwald Lake Refuge

The Service has focused public use planning for the Gorge Refuges at Steigerwald Lake Refuge due to its location at the gateway to the Columbia River Gorge National Scenic Area (Scenic Area) and its close proximity to major urban centers. Steigerwald Lake Refuge is the future site for the Gateway Center to the western entrance of the Scenic Area on the Washington State side.[40,42] A highway turnout with acceleration and deceleration lanes has been constructed to permit future access to the Gateway Center. Projected annual use of the Gateway Center is 125,000 visitors. Construction of the Gateway Center and interpretive trail are awaiting funding and completion of a COE feasibility study. As designed, the Gateway Center will be situated immediately east of Gibbons Creek and south of State Route 14. The facility will integrate exhibit galleries, elevated viewing decks, interpretative displays, classrooms, and administrative space, fitted tightly into the landscape. Compatibility determinations for wildlife-dependent uses of the Gateway Center and interpretive trail were completed in 1999.

Although Steigerwald Lake Refuge is officially closed to the public, the Dike Trail provides access from trailheads located off the Refuge. The Dike Trail trailhead starts at Steamboat Landing Park and extends 3.63 miles east along the dike to end at a locked gate on private land located within the approved acquisition boundary of Steigerwald Lake Refuge. The Port of Camas/Washougal owns a right-of-way to operate and maintain the dike for flood control purposes. The Service has management responsibility for other uses of the dike, including public uses where the dike crosses Refuge land. The Dike Trail is a multiple-use trail, used for bicycling, horseback riding, jogging, birdwatching, and hiking. In 1999, the Service issued a decision to close 0.6 miles of it to horses, dogs, and bicycles. This closure was deemed necessary to provide the public with a high-quality, wildlife-dependent recreational experience. The closure has not been implemented and the Dike Trail remains unofficially open to the public for all uses.

The Service has not conducted a systematic survey of recreational use of the Dike Trail. However, informal surveys of public use can provide a "snap-shot" of the types of uses currently occurring on the trail. Dugger [12] recorded public use on the Dike Trail during 72 visits spanning March 2002 to March 2003. Table 4-11 summarizes the average number of Dike Trail users per mile, including trail segments located on and off the Refuge. Most observations were made in the afternoon or evening. Of the 705 users observed, 66 percent were hiking, while 17 percent each were bicycling or jogging. There was an average of 3 dogs for every 10 users with 40 percent of the dogs being off leash. No horseback riding was observed during this survey, however, Dugger[13] estimated that equestrians used the trail about twice a month based on the droppings he saw. Horses utilizing the Dike Trail must be transported by trailer. Equestrian parking lot capacity is a good measure of the maximum number of horses at any given time. Currently, the parking area can accommodate four vehicles with horse trailers. This regulates maximum horse utilization along the Dike Trail to approximately eight horses.

Franz Lake Refuge

The only developed access to Franz Lake Refuge crosses private property by way of a road easement. The Service-owned easement can only be used for administrative purposes; therefore, public use does not currently occur at this Refuge. In 1997, the Washington Department of Transportation partnered with the Service by widening Washington State Route 14 and installing a walkway and Franz Lake overlook in the right-of-way. Interpretive panels funded by the U.S. Forest Service were installed and now offer information on the Refuge and its habitats and wildlife.

Table 4-10. Average number of visitors per mile of Dike Trail observed during an informal walking survey, conducted from March 2002 to March 2004.

Trail User	Average Number of Visitors per Mile of Trail						
	Spring		Summer		Fall		Winter
	weekday	weekend	weekday	weekend	weekday	weekend	weekend
Humans	3.88	6.00	4.02	3.10	2.34	2.00	4.52
Hikers	2.16	4.12	2.70	1.94	2.00	1.22	3.94
Joggers	0.80	0.62	0.66	0.86	0.34	0.58	0.50
Bikers	0.92	1.26	0.66	0.30	0.00	0.20	0.08
Dogs	1.68	0.96	1.0	0.92	0.66	0.78	2.50

Pierce Refuge

The only developed entrance to the Refuge crosses an unprotected railroad crossing (i.e., no lights or barriers). For safety reasons and due to insufficient staffing and budget, few special events or public recreational activities have taken place there. In 1997, the Service conducted a fishing derby at Pierce Refuge; this activity has not since been held. In recent years, the focus has been on providing environmental education. In 2000, Wolftree Inc., a non-profit science education group, applied for a special use permit to conduct outdoor science classroom activities. Students (mostly high school level) were provided an opportunity to apply scientific methods and perform field study applications. Wolftree Inc. targets students in rural or inner-city schools that cannot usually afford to participate in these kinds of activities. Two-hundred seventeen students participated in Wolftree activities on Pierce Refuge in spring 2000.

During the past three years, Service staff have conducted two to three annual field trips relating to salmonid research within Hardy Creek. Participants have included the Oregon Museum of Science and Industry Science Camp, Mt. Hood Community College, Americorps, Vancouver area high schools, and scientific professionals. Field trip stops are tailored to the interests of the individual group, however, typically include portions of Hardy Creek and visits to the spawning channel. The number of field trip participants is typically less than 40 per visit and averaged 100 participants annually. Additional public use of Pierce Refuge has included staff guided tours and one to two field trips per year, with up to 50 participants per trip.

Refuge Access and Administrative Facilities

Steigerwald Lake Refuge

There is only one current access point to Steigerwald Lake Refuge by the general

public, the Dike Trail. Since the construction of the dike in 1965, the one-lane graveled road on the top of the Columbia River dike provides service access to the Port of Camas/Washougal for maintenance of the dike. The road is open to a variety of non-vehicle uses, including hikers, cyclists, horseback riders, and dog walkers; and provides views of the Refuge to the north, and the Columbia River to the south. Access to the Dike Trail is from a Port of Camas/Washougal Industrial Park owned entry point. The Refuge entrance is marked with boundary signs but there are no interpretive or informational signs at this entry point.

A paved vehicle exit from State Route 14 into the area of the proposed Gateway Center facility is located just east of the Gibbons Creek diversion structure. This area is currently used by occasional visitors to park and take a break from driving. A view of the Refuge wetlands, the Columbia River Gorge, and Mount Hood is provided, but a locked gate prevents access into the Refuge. The gate is used by Refuge staff to drive to the Gibbons Creek diversion structure and elevated channel for maintenance and habitat management.

Near the intersection of Evergreen Highway and State Route 14 in the northeast section of the Refuge, a service road is accessible to Refuge staff through a locked gate from Evergreen Highway. This road provides service access to Refuge staff, a Refuge farming cooperator, and other personnel performing Refuge permitted activities.

The administrative office for the Gorge Refuges recently moved from Pierce Refuge to Steigerwald Lake Refuge, located off Evergreen Highway. This office is currently accessible across a railroad crossing, but railroad personnel have expressed interest in eliminating the crossing and constructing an access road for Refuge staff from State Route 14. This road would be gated and locked, and closed to the general public.

The Refuge office is located in a two story farmhouse built in 1950 that is approximately 1800 square feet. The remnants of a dairy barn still stand just east of the office, including what appears to be a small shop area and milking parlor. A small well house with a working pump and pressure tank is located in the northeast corner of the Stevenson Unit. Another well house is located near the site of the previous farm buildings on the Straub Unit, but the well has been capped, and there is no pump or pressure tank.

Franz Lake Refuge

There is a public viewing deck on State Route 14 at milepost 31.5. There is no public access to Franz Lake Refuge. A gravel road from the highway provides the only vehicle access onto the Refuge. One section of the road is privately-owned. The Service has an easement agreement with the property owner to use the road for administrative purposes. Under this agreement, the Service cannot permit public use of the road across private property.

A manufactured home is located along the entrance road to the Franz Lake dike, along with a well house, small livestock corral, and shed. The home was used by the refuge maintenance worker until he left the Service

in 2001, and has since been rented by a private tenant. The Service no longer needs this residence, therefore, the tenant has been informed that we will be disposing of the mobile home and restoring the grounds after June 2004.

Pierce Refuge

There is no general public access into Pierce Refuge. There are three entrances/exits from State Route 14. The first, just east of milepost 36, is a gated, graveled, seldom used one-lane service entrance to a home owned by the Service.

The second entrance, just east of the first, leads into a resident's driveway, allowing access into the Refuge. Formerly, the 2300 square-foot downstairs of this building was used as the Refuge office. The 1900 square-foot upstairs is now rented to a private tenant and the downstairs is currently used as an office by Service Fire Management personnel.

The third entrance to Pierce Refuge is approximately 0.1 mile east of the second entrance. It has a paved exit off the highway which leads into a one-lane gravel road. It is gated, then crosses a one-lane bridge over Hardy Creek, then a set of railroad tracks owned by the Burlington Northern and Santa Fe Railway. Because the crossing is privately owned, it is not protected with warning lights or gates. This entrance is primarily used by the Service and the WDFW when conducting fish and turtle research. Refuge maintenance and biological staff also periodically use this entrance to Pierce Refuge. The railroad crossing currently receives an average of five trips or less daily. The Burlington Northern and Santa Fe Railway recommends the addition of safety lights and gates on the crossing if vehicle crossings increase.

The highway widens at the entrance to Pierce Refuge, which makes a relatively safe exit from the highway onto the Refuge. Entering the highway, however, requires extreme caution due to a blind corner on the highway east of the entrance point. Data from Washington State Department of Transportation (WDOT) shows one accident in the past decade; a vehicular collision with an animal, in the vicinity of the Refuge entrance. The safety of the entrance may be limiting factor to the expansion of interpretation, education, and research programs. Future significant change to traffic at this intersection will require additional analysis by the Federal Highway Administration and WDOT to determine suitability of this access point.

Other facilities on Pierce Refuge include a 14- by 66-foot manufactured home used to house temporary employees and volunteers working on Refuge projects. Near the residence is well house, storage building, and shop. This shop is currently being used by the Service. A second shop located south of the railroad tracks was the former maintenance facility for the Gorge Refuges.

Cultural Resources

Native Americans Overview

Excavations at the upstream entrance to the Gorge have documented the presence of Native Americans along the Columbia River

for at least the last 10,000 years.[5] Studies at other sites and oral traditions of Native Americans establish that the Columbia River has been a focal point for Native Americans ever since. At the time of European American contact, the Native American Indians who became known as the Chinook lived along the lower Columbia River, including areas that are now the Gorge Refuges. They shared many traits with the Northwest Coast Indians, including art forms, house styles, mortuary practices, and reliance on establishing trade relationships.[5] The distribution of Chinook peoples in the lower Columbia River may have been a relatively recent development, however, as the earliest houses found in the Portland Basin, dating to just over 2,000 years old, are similar to those built by groups living in the Plateau at the time of European American contact. After that time, Plateau type houses were replaced by Chinook style plank houses, which were noted by early explorers as far east as The Dalles.[28]

Because of the mild climate and abundant natural food resources including wapato, camas, salmon, elk, deer, and acorns along the lower Columbia River, the Chinook were able to invest time and labor in the acquisition and production of trade goods. The Columbia River also provided the means for the Chinook to transport and control the exchange of these trade goods. From further down river and the Pacific Coast, the Chinook acquired and processed marine mammal furs, ivory and bone, shell, fish oil, native copper, cedar, and art objects. At the important trading center of The Dalles, the Chinook exchanged these for items from the continental interior. The success of the Chinookan economy is reflected in the number of people it supported, perhaps 12,000 to 14,000 people in the early 1800s.[1]

The Chinookan Indians were divided into a large number of local groups called tribes, bands or nations. Those occupying the Skamania/Cascades area, near the present day Franz Lake and Pierce Refuges, were several groups identified by Lewis and Clark as belonging to the Shahala Nation. These people lived in large villages including Wah-Cleh-Lah below Beacon Rock and Clah-Cleh-Lah between Beacon Rock and the Cascades.[27] The nearest identified Chinookan group to Steigerwald Lake Refuge was known as the Washoughally.[28] Because of their dense population and close contact in trading with, and assisting early European Americans traveling along the Columbia River and at Fort Vancouver, the Chinook of the lower Columbia were frequently exposed to introduced diseases that spread rapidly and killed a large percentage of their people.[4,28] Small, autonomous groups gradually lost their identity and by the 1850s, the surviving peoples were generally referred to simply as Chinook.[28] The Chinook watched while pioneers settled among them, appropriating their traditional lands and resources. Unable to endure the turn of events any longer, in March of 1856 a few Chinook participated in an unsuccessful campaign against their oppressors. Nine of their leaders were hanged. The Chinook survived into the twentieth century as a small but distinct community on the margins of the Columbia River.[4]

The descendants of the early Chinookan people today live primarily in Washington

and Oregon. The Chinook are currently pursuing Federal tribal recognition. The tribe could potentially have at least 800 members, some of whom are currently enrolled in other Northwestern tribes.

Immigrant American Overview

The earliest exploration of the western end of the Columbia River Gorge by Europeans occurred in October of 1792, when Lieutenant William Broughton of the Vancouver Expedition, landed at "point possession" (now Point Vancouver) near the east end of Steigerwald Lake and claimed possession of the Pacific Northwest for Great Britain.[28] Thirteen years later, the famous Lewis and Clark expedition passed by the area when traveling down the Columbia River in November of 1805. They recorded the small prairie above the mouth of the Washougal River at what is now Steigerwald Lake Refuge. They visited the area again on their return trip during April 1806, when they established a food gathering and processing camp just southwest of Steigerwald Lake Refuge at what is now Cottonwood Beach before continuing their return journey. Many other explorers and fur seekers came through the lower Columbia River to hunt and camp in the vicinity of the Gorge Refuges during the first four decades of the nineteenth century.[28]

In the 1840s, thousands of land seekers coming through the Columbia Gorge on their way to the Willamette Valley, viewed the Cascades Portage as the last great obstacle before arriving in the promised land. At first, they used the Indian's well-established path on the north bank to get around the Upper Cascades. Later the building of the portage tramway (1850), the Military Portage Road (1855), and the Oregon Steam Navigation Company Railroad (1860), took much of the danger out of this portage.[4] The roads along the north bank of the river were eventually linked and became Washington State Route 14 in the 1930s. A major railroad line was built along the Washington shore in 1906.[4] It is still in use as part of the Burlington Northern and Santa Fe Railway east-west mainline and crosses portions of all three Gorge Refuges.

It was not until the early 1850s when many of the best agricultural lands in the Willamette Valley had already been claimed by settlers that the first Columbia Gorge land claimants settled along the north shore of the Columbia River. They made a living by developing services for travelers including improving transportation systems, operating stores and hotels, hauling freight, and developing small farms.[4] In the 1850s Joseph Gibbons operated a sawmill on the east bank of Gibbons Creek, probably on land now part of Steigerwald Lake Refuge.[28] Due to the lack of mention of Franz Lake and nearby Arthur Lake by early explorers and settlers it is believed that the lakes were formed sometime between 1850 and 1908 when the land was acquired by Jacob Franz. The lakes may have been formed during one of three major floods that occurred in 1862, 1876, and 1894; with the last one being the largest recorded flood on the Columbia River. During the heyday of steamboats (1880s to 1920s), many people earned a living by cutting and selling cordwood to fuel boilers which propelled the steamboats. Louis and Kenzy Marr ran a

small woodcutting operation in the Franz Lake area and developed a wood loading facility at Marrs landing, a rocky area at the east end of what is now Franz Lake Refuge. The bottomlands around Steigerwald Lake were primarily used for pasture in support of the emerging dairy industry.[28] The land that is now Pierce and Franz Lake Refuges had some pastures that supported cattle grazing.[38,39] Other related industries in the local area included a woolen mill that began operation in Washougal in the early 1900s, which became the Pendelton Woolen Mills, and a small orchard industry that was underway by 1910.[28]

Water-driven fishwheels, whose rotating baskets were used to harvest fish, were introduced to the Columbia River in 1879. The Skamania/Cascades area contained the second largest concentration of fishwheels on the Columbia River, with 28 wheels and 2 canneries between North Bonneville and Skamania Landing. These machines were capable of harvesting thousands of pounds of fish per day. This made salmon fishing a highly efficient and profitable venture.[11] Three fishwheels were located on the shore of what is now the Pierce Refuge. Due to severe declines in fish populations, fishwheels were outlawed in Oregon in 1926, and in Washington in 1934.[11]

Beginning in the 1930s, with Bonneville Dam, the Columbia River dam system was developed for hydropower, flood control, irrigation, and river transportation. In 1966, the bottomlands of the present day Steigerwald Lake Refuge were diked, in preparation for the development of the Washougal Industrial Park to the west of Steigerwald Lake.[28] In the late 1970s, the Second Powerhouse of Bonneville Dam was constructed.

Cultural Resource Surveys

About 70 percent of Service-owned land at Steigerwald Lake Refuge has been surveyed for cultural resources. In 1985, Heritage Research Associates surveyed 682 acres of land that eventually became Steigerwald Lake Refuge. Only minimal evidence of Native American and Immigrant American occupation and use of the area was found. It is almost certain, however, that the Chinook gathered wapato, camas, and other marsh plants at Steigerwald Lake, but these activities do not leave much of an archeological record and no evidence of any prehistoric camps or villages has been found to date. While a few objects dating to the early twentieth century were found on the property (Table 4-12), most historic structures appeared to post date the 1966 diking of the area and no evidence of early Immigrant American occupation was encountered.[28] Additional surveys at Steigerwald Refuge on about 40 acres found no identifiable cultural resources.[7,31]

Only about one percent of the 489.5 acres that currently make up Franz Lake Refuge have been surveyed for cultural resources. A five-acre reconnaissance survey was conducted along the Columbia River shoreline in 1998 in association with a proposed bank stabilization project. No cultural resources were found during the survey and there are no other known surveys on Franz Lake Refuge lands.

Less than one percent of Pierce Refuge has been surveyed for cultural resources.

Several historic sites were identified (Table 4-12) in two surveys covering about 28 acres.[25,31]

While not discussed in detail here, additional surveys have identified archeological and historical sites on lands adjacent to the Refuges. Because of this it is highly likely that there are additional sites on the three Refuges that have not yet been located due to a lack of surveys.

Table 4-11. Known cultural sites and National Register of Historic Places status (PR: Pierce Refuge; SLR: Steigerwald Lake Refuge).

Refuge	Description	NRHP status	References
SLR	Joseph Gibbons farmstead and sawmill sites (1850-1870s)	undetermined	Minor and Beckham 1985
SLR	1920s farm buildings	not eligible	Minor and Beckham 1985
PR	Castle Rock Fishwheel remains off shoreline	undetermined	FWS 1991b; Donaldson & Cramer 1971
PR	1880s and more recent buildings and foundations	undetermined	Keeler 1985; Raymond 1994
PR	Remains of late 19th or early 20th century railroad grade at mouth of Hardy Creek	undetermined	Keeler 1985; Raymond 1994

Socioeconomic Environment

Demographics

The Portland-Vancouver metropolitan area is the largest human population center in Oregon and the second largest population center in the State of Washington. The metropolitan area has grown from a population of 100,000 in 1890 to more than 1.9 million in 2000. That figure is estimated to increase to more than 3.4 million by 2025. Clark County (Steigerwald Lake Refuge) is within the metropolitan area.

The population in Clark County has grown 45 percent from 1990 to 2000, and most residents live in rapidly growing suburban communities. In 1990, 36 percent of workers commuted outside the County to work primarily in the greater Portland, Oregon, area. Primary occupations are providing services, manufacturing, and sales. Household income levels are higher relative to the State average. Table 4-13 compares County and State socioeconomic data. Skamania County (Pierce and Franz Lake Refuges) is outside the Portland-Vancouver metropolitan area. Between 1990 and 2000, Skamania County's population grew 19.1 percent. In 1990, 46 percent of workers commuted outside the County to work. The Federal Government is the largest employer in the County. Income levels have been below the State average since the early 1980s (Table 4-13).

The population of both Counties has become more diverse since 1990 with the proportion of whites decreasing, while the Hispanic and Asian populations are growing (Table 4-13). The population age structure of both counties has a higher proportion of persons under the age of 18 compared with Washington State. This suggests that the Counties have a higher than average need for educational opportunities and facilities. Education and income levels are higher in Clark County compared to Skamania County, as depicted in Table 4-13.

Land Use

Historically, forested bottomlands along the lower Columbia River, including the Steigerwald Lake basin, were cleared to make room for pastures, crops, and dairy farms. After World War II, as the populations of Clark County grew, a large portion of the agricultural lands were and continue to be lost to urbanization. Data from 1992 showed one-fifth of Clark County was farmland, with crops comprising the largest area; however, livestock, nurseries, and greenhouses provided the greatest farm income. Half of the land area in Clark County is non-Federal timberland, while Federal timberlands account for less than one percent of the land area (Table 4-14). In Clark County, the predominant land use along the Columbia River is industrial and commercial shipping. The Vancouver urban area and communities of Camas and Washougal have large residential and commercial areas. Steigerwald Lake Refuge is adjacent to Washougal and provides open space in this area.

Table 4-12. Socioeconomic profile of Clark and Skamania Counties and Washington State

Parameter	Clark County	Skamania County	Washington
Population	345,238	9,872	5,894,121
Density (# people per mile^2)	549.7	6.0	88.6
Race/ethnicity (% of population)			
White	88.8	92.1	81.8
Black	1.7	0.3	3.2
Asian	3.2	0.5	5.5
Native Hawaiian and Other Pacific Is.	0.4	0.2	1.3
Native American and Alaskan	0.8	2.2	1.6
Other Race	2.0	2.4	3.9
Two or more races	3.1	2.2	3.6
Hispanic Origin (any race)	4.7	4.0	7.5
Education			
% Population over 25 with high school degree	87.8	85.9	87.1
% Population over 25 with Bachelor's degree	22.1	16.8	27.7
Income and Poverty (1999)			
Median household income	$48,376	$39,317	$45,776
% Persons below poverty level	9.1	13.1	10.6

Skamania County is adjacent to Clark County, but is less influenced by the metropolitan area and has very different patterns of land use compared to Clark County. The County is dominated by Gifford Pinchot National Forest, and the Mount Saint Helens National Volcanic Monument is in the northwest corner. Lands administered by the U.S. Forest Service account for 80 percent of the land in the County, while non-Federal timberlands comprise an additional 19 percent of the County's land area (Table 4-14). Farmland decreased in Skamania County by more than 50 percent between 1982 and 1992.

Table 4-13. Land use profile for Clark and Skamania Counties. Most values are from the 1990s.

Land Use	Proportion of Total Land Area	
	Clark Co.	Skamania Co.
Federal Timberlands	less than 1%	80%
Non-Federal Timberlands	50%	19%
Agriculture	21%	less than 1%
Residential	11%	less than 1%
Industrial and Commercial	2%	less than 1%

Recreation

Washington State's outdoor recreational priorities are water access, trails, natural areas, and fish and wildlife habitat.[22] The public wants facilities in settings that include water access more than any other type of setting. State and local governments share the bulk of the responsibility of providing water access. Since 1990 local boating facilities and ramps have increased or improved. A 146 mile lower Columbia River Water Trail from Bonneville Dam to the Pacific Ocean is proposed so that people in non-motorized boats can travel for day and overnight trips. The Water Trail is divided into seven two-day paddles of approximately 20 miles each. The benefits of this identified Water Trail system are safety, stewardship, and regional recognition (Lower Columbia River Estuary Partnership). The most popular and most rapidly-growing outdoor activities are those that include the use of trails. Walking and hiking have emerged as major and rapidly-growing recreational activities. Estimates of outdoor recreation activities project a 34 percent increase in walking and a 20 percent increase in hiking over the next 20 years. Bicycling is a growing activity with a projected 29 percent increase during the next 20 years.[23] Regionally, there is a lack of long trails that connect multiple lands. The U.S. Forest Service and the Chinook Trail Association are interested in developing a trail through the Scenic Area by linking existing trails, including the Dike Trail, with new trails.

The public desires mostly natural or natural appearing outdoor recreation settings that are safe from accidents and crime.[9] There is a growing public appreciation and desire to protect the environment, especially sites that contain significant conservation resources such as rare flora, fauna, geologic features, natural history, and other natural resources of scientific or educational

interest. People want to enjoy nature and observe wildlife.

During the next 20 years, the demand for nature activities is estimated to increase by 37 percent in Washington.[23] Local school districts and the public would like to see more environmental education opportunities on public lands.[9] Projections for select consumptive outdoor activities identify a decline in participation in Washington. Hunting is anticipated to decline by 21 percent, while fishing activities are anticipated to decline by 10 percent over the next 20 years.[23] These traditional consumptive activities are being surpassed by nonconsumptive activities such as wildlife observation and photography.

The three Refuges are located in the Columbia River Gorge National Scenic Area. Established in 1986 to protect an area of world renowned scenery and diverse recreation opportunities, the Scenic Area is also a major tourist destination, an area of economic importance, and home to over 44,000 people. While public access to, and use of, the Refuges is currently limited, the potential users include people from the local communities adjacent to the Refuges, recreationists from the greater Portland-Vancouver metropolitan area, and national and international tourists seeking to enjoy and learn about the Columbia River Gorge.

The Refuges are located within a 60-minute drive of the Portland/Vancouver metropolitan area. State Route 14 (SR14) connects the Refuges to urban centers, providing a highly scenic travel and recreation corridor through the Scenic Area. Opportunities for outdoor recreation along SR14 abound, including several public areas close to the Refuges (Table 4-15). Despite these many opportunities, demand for outdoor recreation exceeds supply and is predicted to continue to grow as nearby urban areas expand.[9]

In anticipation of increasing public demand for outdoor recreation in Washington, two additional major recreational area improvements are proposed in the vicinity of the Refuges: Captain William Clark Park at Cottonwood Beach, and Doetsch Ranch. Captain William Clark Park at Cottonwood Beach is located immediately west of Steigerwald Lake Refuge. This 75-acre site is owned and maintained by the Port of Camas/Washougal. The sand beach, open meadow, and riparian woodland are popular during the summer for swimming, wading, and picnicking. The Dike Trail passes along the north boundary of the property and provides a year-round trail for hiking, bicycling, jogging, and horseback riding. Camping and horseback riding also occur on the beach. A master plan has been developed and grants sought for recreation improvements at William Clark Park. Construction is expected to begin in 2004, with completion planned the end of summer 2005. When completed, there will be tent and RV camping sites, horseshoe pits, volleyball courts, picnic tables, restrooms, and historical interpretation displays. Expansion of the day dock at Steamboat Landing and a new dock are also proposed. Historical interpretation and living history events will focus on: Lewis and Clark's six-day provision camp established here in

1806; Native Americans of the lower Columbia River; and Washougal's early history and settlement. Proposed environmental education facilities include two boardwalks with interpretation of Ice Age floods, resident wildlife, native shoreline plants, and forested wetlands.

Doetsch Ranch is located about midway between Franz Lake Refuge and Pierce Refuge. Owned by Washington State Parks, this 160-acre site offers scenic views of the Gorge and Beacon Rock, as well as a broad sandy beach. Currently, some hiking occurs on the property but there are no signs to identify the area and parking is limited. Future plans for the property include a large multi-purpose, resource-based public recreation area.[42] Opportunities and facilities would be developed to provide beach access for swimming and bank fishing; trails for walking and hiking; interpretation of wildlife and other natural resources; and interpretation of cultural resources and historical events. Doetsch Ranch could become the primary developed recreation opportunity on the Washington side of the Columbia River, accommodating 600 to 900 people at one time.[42]

Table 4-14. Public use opportunities available in Washington near the Gorge Refuges.

Site	Interpretation	Wildlife Viewing	Hiking Trail	Biking	Dog Walking	Picnicking	Fishing	Camping	Horseback Riding	Boat Launch
Steamboat Landing	X	X	X	X	X		X		X	
Clark Park at Cottonwood Beach		X	X	X	X		A		X	
Steigerwald Lake Overlook	X	X								
Mount Pleasant Grange	X									
Saint Cloud Recreation Area	X	X	X		X	X	A			
Sams-Walker Recreation Area	X	X	X		X	X	A			
Beacon Rock State Park	X	X	X	X	X	X	X	X	X	X
Town of North Bonneville			X	X	X	X				
Hamilton Island Recreation Area		X	X		X	X	X			X
Fort Cascade Recreation Area	X	X	X		X	X	X			
Bonneville Dam and Visitor Center	X	X					X			
Pacific Crest Trail Head at Bonneville (some uses occurring along trail)		X	X		X		A	X		

X = Existing; A=Allowed but no developed facilities

Research and Monitoring

Steigerwald Lake Refuge

Air Quality Monitoring.

Air quality data collected through a network of monitoring stations in the Columbia River Gorge Scenic Area will be used to develop a regional air quality strategy. The network was recently expanded to evaluate spatial and temporal patterns of haze. A monitoring station was added at Steigerwald Lake Refuge in 2002. Surface climatic data (temperature, humidity, wind speed and direction), coupled with localized air quality parameters, will assist in analysis of regional haze gradients, daily haze patterns, and seasonal relationships to air quality.

Lamprey Study.

The U.S. Geological Survey is evaluating lamprey use in Gibbons Creek. Lamprey collected will be used to determine response of juveniles to temperature changes and olfactory stimuli, and to improve identification techniques.

Franz Lake Refuge

Impacts of Mosquito Control Treatments.

The Washington Cooperative Fish and Wildlife Research Unit will examine the impacts of *Bacillus thuringiensis israelensis* (B.t.i.). on non-target invertebrate species at Franz Lake Refuge. Invertebrate species composition and abundance were sampled during 2003 within B.t.i treatment plots and untreated control plots to determine the potential non-target effects of B.t.i. on the aquatic food web and the potential for indirect impacts on wildlife. A final report is expected to be completed by October 2004.

Fish Distribution and Diet Study.

Objectives of this study are to: (1) document the species of fish occurring at Franz Lake Refuge; (2) evaluate fish distribution relative to habitat features; and (3) describe the diets of fish inhabiting Franz Lake Refuge, particularly juvenile salmonids. Results will be coupled with the Impacts of B.t.i. Treatment of Mosquito Control study to aid in evaluating effects of mosquito control treatments to juvenile salmonids.

Pierce Refuge

Chum Salmon Monitoring.

The Service monitors chum salmon spawning and reproduction in Hardy Creek. Adults are trapped and tagged to evaluate their movements within the watershed, and to determine the reproductive population utilizing the Refuge. Redds (spawning beds) are monitored for hatching success, as well as for a variety of water quality parameters. Out-migrating smolt are trapped and marked to evaluate passage and count smolt for reproduction estimates.

Assessment of Springs and Seeps.

The U.S. Army Corp of Engineers initiated a study in 2002 to assess the spring and seep systems on Pierce Refuge. Sixteen summer and 39 winter springs and seeps have been identified along or adjacent to Hardy Creek. These sites are being evaluated on an annual cycle to determine flow volumes, flow

duration, and water quality. This data will be analyzed to determine the potential for creating additional salmonid spawning habitat along Hardy Creek.

Water Pressure and Temperature Monitoring.

Pacific Northwest National Laboratory biologists installed remote monitoring equipment at Pierce Refuge to monitor in-stream conditions associated with a chum salmon spawning area that occurs adjacent to the Refuge. This area is heavily influenced by the Bonneville Dam. Results will be used to evaluate the effects of water level fluctuations and temperature changes on chum salmon spawning and incubation.

Western Pond Turtle Project.

The WDFW is monitoring movements and survival of western pond turtles equipped with radio transmitters and released at Pierce Refuge. Under an existing agreement between WDFW and the Service, additional turtles will be released and monitored until a self-sustaining population of western pond turtles is established at Pierce Refuge.

Columbia Yellowcress Monitoring.

The Nature Conservancy and volunteers conduct annual surveys along the shorelines of the Refuge to evaluate the status of Columbia yellowcress, a plant species listed as threatened by the State of Washington. These surveys have been conducted since 1991, and include a population assessment, as well as a habitat assessment that includes growing conditions and invasive species encroachment.

Refuge Management Economics

The Refuge staff consists of one full time Refuge Manager for the Steigerwald Lake, Franz Lake, and Pierce National Wildlife Refuges. The office for the Gorge Refuges is located at the Steigerwald Lake Refuge on the Columbia Land Trust Unit adjacent to the city of Washougal. Management of the Gorge Refuges is routinely dependant upon the availability of Ridgefield Refuge Complex support staff for various Refuge projects and services. Support staff for field operations includes a maintenance worker, outdoor recreation planner, biological technician and a wildlife biologist. These positions are utilized throughout the complex of Refuges and travel to the area to work on various specific projects is required. During the summer months a Youth Conservation Corps crew of 5 members and a crew leader generally provide limited project support to the Refuges for 5 to 10 days each year. In 2002, the Service provided approximately $103,000 in staff salaries and benefits to the administration, resource management, and maintenance of the Gorge Refuges.

In addition to providing salaries and benefits, goods and services were purchased by the Service in the local communities totaling approximately $463,000 in 2002; approximately 75 percent was spent in Clark County. Nearly all of the expenditures for 2002 were for one-time only flood damage restoration, maintenance management system, and Federal roads projects.

Refuge management baseline costs not including salaries are estimated to be $74,000 per year for operations, resource

management, and maintenance activities. Approximately 70 percent of these funds will be utilized for wildlife and habitat projects, and the remaining 30 percent will be utilized for public use projects.

National Wildlife Refuges contribute funds to local counties through two revenue sharing programs, one that applies to Refuge lands reserved from the public domain, and one that applies to lands purchased in fee title. The Refuge Revenue Sharing Act of 1998 authorizes payments to the county in which Service owned lands are located. The Refuge lands within the Columbia River Gorge are comprised of lands owned in fee-title. For lands owned in fee-title, the Service is required to pay counties up to 0.075 percent of the land's appraised value each year, out of the Refuge Revenue Sharing Fund. From 1998 to 2002, the Federal government paid an average of $12,000 for Franz Lake Refuge and Pierce Refuge to Skamania County; and $19,000 to Clark County for Steigerwald Lake Refuge.

In addition to expenses incurred during Refuge staff operations, the Service's Lower Columbia River Fisheries Program conducts annual salmon research activities and habitat development at all three Refuges. From two to four staff biologists work on these activities, primarily from November through May. During the research period over the winter of 2002 to 2003 and into the summer of 2003, the Service spent an additional $135,000 for staff salaries and benefits, travel expenses, supplies and equipment in Clark and Skamania Counties.

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