Chapter 4. Biological Environment

Photos: Above, White-tailed deer mother and fawn. Right, tracking Columbian white-tailed deer / USFWS

Chapter 4. Biological Environment

4.1 Biological Integrity Analysis

The National Wildlife Refuges System Improvement Act of 1997 directs the Service to ensure that the biological integrity, diversity, and environmental health (BIDEH) of the Refuge System are maintained for the benefit of present and future generations of Americans. In simplistic terms, elements of BIDEH are represented by native fish, wildlife, plants, and their habitats as well as those ecological processes that support them. The Refuge System policy on BIDEH (601 FW 3) also provides guidance on consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges and in associated ecosystems, that represents BIDEH on each refuge.

The BIDEH of the Columbia River estuary has been profoundly impacted by human activities. Land development for agriculture, industry, and housing, made possible by diking and draining, has disconnected large areas of the historical floodplain, marsh, and swamp habitat from the estuary (LCREP 1999). From Bonneville Dam to the river's mouth, an estimated 84,000 acres of floodplain have been lost from the construction of dikes (Marriott and McEwen 2005). In the lower estuary (the river mouth to the upstream end of Puget Island), where most refuge lands are located, Thomas (1983) estimated that more than 23,000 acres of forested and scrub-shrub tidal swamp and nearly 7,000 acres of tidal marsh, have been lost since 1870. These acreages represent 77 percent and 43 percent, respectively, of the historical total acreage. Further, much of the remaining floodplain, marsh, and swamp habitat either has been or is in the process of being degraded by the proliferation of nonnative plants such as purple loosestrife, reed canarygrass, yellow iris, and Japanese knotweed (LCREP 1999).

As a consequence of habitat loss, many of the estuary's native wildlife species have declined. Other factors such as over utilization by humans and pollution have played a role in wildlife losses, but it is certain that wildlife cannot persist without suitable habitat. Twenty-four wildlife and plant species of the lower river and estuary are now federally listed as endangered or threatened, including 12 runs (evolutionarily significant units) of salmon and steelhead.

The habitat and wildlife losses have magnified the importance of the refuges' conservation and management activities. The Lewis and Clark Refuge's acquisition boundary encompasses 33,000 acres within the estuary, including 6,300 acres of tidal swamp and marsh. Julia Butler Hansen Refuge contains approximately 2,200 acres of tidal marsh and swamp and 3,800 acres of riparian habitat that includes forest, sloughs and nontidal marsh. These habitats represent vegetation communities important for the maintenance of BIDEH on the lower Columbia River. Together, the refuges protect a majority of the floodplain wetlands in a 30-mile stretch of the estuary. Thus, they are vital to preserving the natural environment as well as native species of fish, wildlife, and plants of the entire estuary.

Even though refuge lands are protected from development, the refuge habitats and its wildlife still face threats. Invasive plants and pest animals can displace and compete for resources with native species. Reed canarygrass is especially pervasive and monopolizes hundreds of acres of

aquatic and upland habitat. Reed canary grass has little value to wildlife compared to the native diversity of wetland plants it displaces. Purple loosestrife and yellow iris have spread rapidly in tidal and nontidal marsh. Japanese knotweed displaces native shrubs such as red-osier dogwood. Nutrias consume large amounts of marsh vegetation. New invasive species may appear in the future. Pollution is also a threat in that urban runoff washes chemicals and sewage into the river and through the refuges. Contaminants such as polychlorinated biphenyls (PCBs), dioxin, furans, polynuclear aromatic hydrocarbons (PAHs), pesticides, and heavy metals are found in the water, sediments, and organisms of the estuary (LCREP 1999). Organochlorine contaminants have impaired the reproduction of bald eagles (Buck 2005), river otters (Henny 1996), and possibly great blue herons (Thomas and Anthony 1997), among other species. Oil and chemical spills in the river have occurred in the past and almost certainly will occur again in the future.

These problems, while serious, are surmountable. Pollutant sources are being addressed and existing contaminants in the environment are being cleaned up. New methods of slowing or stopping the spread of invasive plants are being adopted. Overall, the refuge environment is still relatively healthy and the varied habitats support an abundance and diversity of wildlife.

4.2 Identification of Refuge Resources of Concern and Analysis

In preparing this plan, the Service reviewed other local, regional, and national plans that pertain to the wildlife and habitats of the Columbia River estuary. The Service also sought input from Washington and Oregon state conservation agencies, nongovernmental organizations, and the general public. The refuge purposes, as stated in the various establishment documents for each refuge (see Chapter 1) were carefully reviewed as was the refuges contribution to maintenance of BIDEH on the lower Columbia River. As a result of this information gathering and review process, certain species and habitats were identified as resources of concern (Tables 4-1a and 4-1b). From this list of resources of concern, those species and habitats that are most representative of the refuges' purposes and habitats, BIDEH (Tables 4-2a and 4-2b), and other Service and ecosystem priorities, were chosen as priority resources of concern. Examples include the CWT deer for Julia Butler Hansen Refuge—this species represents refuge purposes; and the tundra swan, it represents species that utilize emergent wetlands for Lewis and Clark Refuge. A complete list of priority resources of concern (i.e., focal species and habitat types) for each refuge is contained in (Tables 4-3a and 4-3b). These priority resources of concern are the species and habitats whose conservation and enhancement will guide refuge management into the future. Potential management actions will be evaluated on their effectiveness in achieving refuge goals and objectives for priority resources of concern.

Management of refuge focal species and habitats that support them will benefit many of the other native species that are present on the refuges and in lower Columbia River. Many of the species that will benefit from management of the refuges' focal species are identified in the "Other Benefiting Species" column in (Tables 4-3a and 4-3b). Through the consideration of BIDEH, the refuges will provide for or maintain all appropriate native habitats and species. Refuge management priorities may change over time, and because the CCP is designed to be a living, flexible document, changes will be made at appropriate times.

Table 4-1a Comprehensive List of Resources of Concern for Julia Butler Hansen Refuge.

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation Concern [c]	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A.Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
CWT Deer	✓	✓	E[1]	E[1]	SS[1]				W,O				✓		S1[3]	S2[3]	Grassland, evergreen and deciduous forested wetland, scrub-shrub wetland, tidal and nontidal marsh, riparian forest and shrub.
Roosevelt Elk	✓																Grassland, riparian forest and shrub, tidal and nontidal marsh.
Steller Sea Lion			T[1]												S2[3]	S2[3]	Open water, sandbars for resting.
Fringed Myotis Bat			So C[1]		SS[1]				O						S3[3]	S2[3]	Riparian forest, grasslands, snags for roosting.
Longeared Myotis Bat			So C[1]		SS[1]										S4[3]	S4[3]	Riparian forest.
Yuma Myotis Bat			So C[1]													S3[3]	Riparian forest.
White-footed vole			So C[1]		SS[1]											S3[3]	Riparian forest.
Double-crested Cormorant								✓									Open water, sloughs, upland dredge spoil (nesting).
Great Blue Heron									W		✓						Tidal and nonmarsh, shallow open water, forested wetland and riparian forest (nesting).
Tundra Swan	✓											✓		✓			Tidal and nontidal marsh.
Cackling Goose	✓							✓				✓					Grassland, open water (roosting), tidal and nontidal marsh.
Dusky Canada Goose	✓							✓	O			✓	✓			S3[3]	Grassland, open water (roosting), tidal and nontidal marsh.
Western Canada Goose	✓							✓				✓					Grassland, open water (roosting), tidal and nontidal marsh.
Tule Greater White-fronted Goose	✓								W			✓					Grassland, open water (roosting), tidal and nontidal marsh.
Wood Duck	✓							✓							S4[3]		Forested wetland, riparian forest, tidal and nontidal marsh.

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation Concern [c]	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A. Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
American Wigeon	✓							✓									Grassland, tidal and nontidal marsh.
Mallard	✓							✓									Tidal and nontidal marsh.
Northern Pintail	✓							✓	W								Tidal and nontidal marsh.
Greater Scaup	✓							✓	W						S3[3]		Open water, sloughs.
Lesser Scaup	✓							✓							S3[3]		Open water, sloughs.
Bald Eagle			So c[1]	T[1]	T[1]				W,O				✓	✓	S4[3]	S4[3]	Forested wetland, riparian forest, open water, sloughs, tidal and nontidal marsh.
American Peregrine Falcon			So C[1]	SS[1]	E[1]		✓	✓	O					✓	S2[3]	S2[3]	Forested wetland, riparian forest, tidal and nontidal marsh, cliffs/man-made nesting structures.
Merlin				SC[1]											S3[3]		Grassland, forested wetland, riparian forest, tidal and nontidal marsh.
Northern Harrier						✓	✓								S4[3]		Grassland, tidal and nontidal marsh.
American Kestrel						✓											Grassland, riparian forest.
Red-shouldered Hawk						✓											Grassland, riparian forest.
Cooper's Hawk						✓								✓	S4[3]		Riparian forest.
Band-tailed Pigeon	✓		So C[1]			✓		✓	O			✓			S4[3]	S3[3]	Riparian forest and shrub.
Northern Saw-whet Owl								✓						✓	S4[3]		Riparian forest.
Short-eared Owl								✓	O						S4[3]		Grassland, tidal and nontidal marsh.
Western Screech Owl						✓									S4[3]		Riparian forest.
Dunlin							✓			4[2]							Tidal flats and sandbars.
Wilson's Snipe										4[2]							Grassland, tidal and nontidal marsh.
Greater Yellowlegs										4[2]							Tidal and nontidal marsh, tidal flats, sandbars.
Western Sandpiper										4[2]							Tidal flats and sandbars.
Killdeer										4[2]							Grassland, tidal and nontidal marsh.
Marbled Murrelet			T[1]	T[1]	T[1]			✓	W,O						S3[3]	S2[3]	Old growth forest for nesting.

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation Concern [c]	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A. Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
Olive-sided Flycatcher			So C[1]		SS[1]	✓	✓	✓	O					✓	S4[3]	S3[3]	Forested wetland, riparian forest, tidal and nontidal marsh.
Little Willow Flycatcher			So C[1]		SS[1]	✓			O					✓		S3[3]	Riparian shrub.
Pacific-slope Flycatcher						✓											Forested wetland, riparian forest.
Hammond's Flycatcher						✓											Forested wetland, riparian forest.
Red-eyed Vireo						✓							✓		S3[3]		Forested wetland, riparian forest.
Swainson's Thrush						✓											Forested wetland, riparian forest.
Varied Thrush						✓											Forested wetland, riparian forest.
Rufous Hummingbird						✓	✓							✓			Forested wetland, riparian forest, scrub-shrub.
Horned Lark (*strigata*)			C[1]	E[1]		✓	✓		W,O						S1[3]	S2[3]	Grassland (sparse), dredge spoil.
Western Meadowlark						✓			O						S4[3]	S4[3]	Grassland with perch sites.
Western Bluebird									W,O						S3[3]	S4[3]	Riparian forest/grassland mosaic, snags.
Yellow Warbler						✓							✓				Forested wetlands, riparian forest, scrub-shrub.
Wilson's Warbler						✓											Forested wetlands, riparian forest, deciduous understory.
Hermit Warbler						✓									S4[3]		Riparian forest, forested wetland.
Winter Wren						✓											Riparian forest.
Purple Martin			So C[1]	SC[1]	SS[1]	✓			W						S3[3]	S2[3]	Forested wetlands, riparian forest, snags, open water.
Tree Swallow						✓											Forested wetlands, riparian forest – open water.
Vaux's Swift				SC[1]		✓			W						S3[3]		Forested wetland, riparian forest – hollow trees.
Pileated Wood-pecker				SC[1]	SS[1]	✓			W						S4[3]		Forested wetland, riparian forest – large snags.
Downy Woodpecker						✓											Forested wetland, riparian forest.

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation Concern [c]	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A.Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
Brown Creeper						✓											Forested wetland, riparian forest.
Red Crossbill						✓			O						S4[3]		Riparian forest, forested wetland (Sitka spruce).
Chinook Salmon	✓	✓	T[1], E[1]	SC[1]	SS[1]				W,O				✓			S2[3]	Open water and sloughs for migrating, tidal marsh for juvenile foraging.
Chum Salmon	✓	✓	T[1]	SC[1]	SS[1]				W,O				✓		S3[3]	S2[3]	Open water and sloughs for migrating, tidal marsh for juvenile foraging.
Coho Salmon	✓	✓	T[1]		SS[1]				W,O				✓		S3[3]	S2[3]	Open water and sloughs for migrating, tidal marsh for juvenile foraging.
Steelhead	✓	✓	T[1]	SC[1]	SS[1]				W,O				✓			S2[3]	Open water and sloughs for migrating, tidal marsh for juvenile foraging.
Coastal Cutthroat trout	✓		So C[1]		SS[1]				W,O				✓			S2[3]	Open water and sloughs, tidal marsh.
Bull Trout			T[1]	SC[1]	SS[1]				W,O				✓			S2[3]	Open water and sloughs.
Red-legged Frog			So C[1]		SS[1]				O						S4[3]	S4[3]	Tidal and nontidal marsh, forested wetland, riparian forest, scrub-shrub.
Western Toad				SC[1]	SS[1]				W,O						S3[3]	S3[3]	Riparian forest, grassland, marsh.
Western Painted Turtle					SS[1]				O						S4[3]	S2[3]	Sloughs, nontidal marsh, adjacent sparse grassland for nesting.
Western Pond Turtle			So C[1]	E[1]	SS[1]				W						S1[3]	S2[3]	Sloughs, nontidal marsh, adjacent sparse grassland for nesting, riparian forest, forested wetlands, scrub-shrub.
Valley Silverspot Butterfly				SC[1]					W						S2[3]		Grasslands.
California Floater mollusk			So C[1]	SC[1]					W						S2[3]	S1[3]	Open water, sloughs.
Winged Floater mollusk									W								Open water, sloughs.

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation Concern [c]	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A. Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
Oregon Floater mollusk									W						S3[3]	S3[3]	Open water, sloughs.
Sitka Spruce Swamp	✓	✓															
Cottonwood Tidal Swamp	✓	✓															
Scrub-shrub Tidal Swamp	✓	✓															
Riparian Forest	✓	✓															
Tidal Marsh	✓	✓															

[1] T = Threatened; E = Endangered; SoC = Species of Concern; SC = State Candidate; SS = State Sensitive
[2]Category 4 = species of high concern
[3]S1 = critically imperiled; S2 = imperiled; S3 = rare, uncommon or threatened; S4 = not rare, apparently secure, but with cause for long-term concern
[a]U.S. Fish and Wildlife Service 2001
[b]Altman 1999, Altman 2000
[c]U.S. Fish and Wildlife Service 2002
[d]U.S. Fish and Wildlife Service 2005a
[e]Washington Dept. Fish and Wildlife 2005, Oregon Dept. Fish and Wildlife 2006
[f]Drut and Buchanan 2000
[g]Kushlan et al. 2002
[h]Subcommittee on Dusky Canada Geese 1992, Pacific Flyway Council 1999, Subcommittee on Pacific Population of Western Canada Geese 2000, Pacific Flyway Council 1983, Pacific Flyway Council 2001
[i]Northwest Power and Conservation Council 2004
[j]Oregon Habitat Joint Venture 1994 (North American Waterfowl Management Plan)
[k]Washington Dept. of Natural Resources 2005 (Washington Natural Heritage Plan, State rankings)
[l]Oregon Natural Heritage Program, State rankings (Oregon Natural Heritage Program 2004)

Table 4-1b Comprehensive List of Resources of Concern for Lewis and Clark Refuge.

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A.Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
Columbian White-tailed Deer	✓		E[1]	E[1]	SS[1]				W,O				✓		S1[3]	S2[3]	Grassland, evergreen and deciduous forested wetland, scrub-shrub wetland, tidal and nontidal marsh, riparian forest and shrub.
Fringed Myotis Bat			So C[1]		SS[1]				O						S3[3]	S2[3]	Riparian forest.
Long-eared Myotis			So C[1]		SS[1]										S4[3]	S4[3]	Riparian forest.
Yuma Bat			So C[1]													S3[3]	Riparian forest.
White-footed Vole			So C[1]		SS[1]											S3[3]	Riparian forest.
Steller Sea Lion			T[1]												S2[3]	S2[3]	Open water, sandbars for resting.
Western Grebe				SC[1]					W		✓				S3[3]	S3[3]	Open water, tidal marsh.
Brown Pelican			T[1]	E[1]	E[1]			✓	W,O		✓				S3[3]	S2[3]	Open water (shallow for foraging).
Double-crested Cormorant								✓			✓						Open water for foraging.
Great Blue Heron									W		✓						Tidal and nonmarsh, shallow open water, forested wetland and riparian forest (nesting).
Tundra Swan	✓											✓		✓			Tidal and nontidal marsh.
Cackling Goose	✓							✓				✓					Grassland, open water (roosting), tidal/nontidal marsh.
Dusky Canada Goose	✓							✓	O			✓	✓			S3[3]	Grassland, open water (roosting), tidal and nontidal marsh.
Western Canada Goose	✓							✓				✓					Grassland, open water (roosting), tidal and nontidal marsh.
Tule Greater White-fronted Goose	✓								W			✓					Grassland, open water (roosting), tidal and nontidal marsh.
Wood Duck	✓							✓							S4[3]		Forested wetland, riparian forest, tidal and nontidal marsh.

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A.Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
American Wigeon	✓							✓									Grassland, tidal and nontidal marsh.
Mallard	✓							✓									Tidal and nontidal marsh.
Northern Pintail	✓							✓	W								Tidal and nontidal marsh.
Greater Scaup	✓							✓	W						S3[3]		Open water, sloughs.
Lesser Scaup	✓							✓							S3[3]		Open water, sloughs.
Bald Eagle			So C[1]	T[1]	T[1]				W,O				✓	✓	S4[3]	S4[3]	Forested wetland, riparian forest, open water, sloughs, tidal and nontidal marsh.
American Peregrine Falcon			So C[1]	SS[1]	E[1]		✓	✓	O					✓	S2[3]	S2[3]	Forested wetland, riparian forest, tidal and nontidal marsh.
Merlin				SC[1]											S3[3]		Grassland, forested wetland, riparian forest, tidal and nontidal marsh.
Northern Harrier						✓	✓								S4[3]		Grassland, tidal and nontidal marsh.
American Kestrel						✓											Grassland, riparian forest.
Red-shouldered Hawk						✓											Grassland, riparian forest.
Cooper's Hawk						✓								✓	S4[3]		Riparian forest.
Band-tailed Pigeon	✓		So C[1]			✓		✓	O			✓			S4[3]	S3[3]	Riparian forest and shrub.
Northern Saw-whet Owl								✓						✓	S4[3]		Riparian forest.
Short-eared Owl								✓	O						S4[3]		Grassland, tidal and nontidal marsh.
Western Screech Owl						✓									S4[3]		Riparian forest.
Dunlin							✓			4[2]							Tidal flats and sandbars.
Wilson's Snipe										4[2]							Grassland, tidal and nontidal marsh.
Greater Yellowlegs										4[2]							Tidal and nontidal marsh, tidal flats, sandbars.
Western Sandpiper										4[2]							Tidal flats and sandbars.
Killdeer										4[2]							Grassland, tidal and nontidal marsh.
Caspian Tern							✓	✓	O		✓		✓		S3[3]		Dredge-spoil islands for nesting.
Marbled Murrelet			T[1]	T[1]	T[1]			✓	W,O						S3[3]	S2[3]	Old growth forest for nesting.
Olive-sided			So		SS[1]	✓	✓	✓	O					✓	S4[3]	S3[3]	Forested wetland, riparian forest, tidal and nontidal

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A.Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
Flycatcher			C[1]														marsh.
Little Willow Flycatcher			So C[1]		SS[1]	✓			O					✓		S3[3]	Riparian shrub.
Pacific-slope Flycatcher						✓											Forested wetland, riparian forest.
Hammond's Flycatcher						✓											Forested wetland, riparian forest.
Red-eyed Vireo						✓							✓		S3[3]		Forested wetland, riparian forest.
Swainson's Thrush						✓											Forested wetland, riparian forest.
Varied Thrush						✓											Forested wetland, riparian forest.
Rufous Hummingbird						✓	✓							✓			Forested wetland, riparian forest, scrub-shrub
Horned Lark (*strigata*)			C[1]	E[1]		✓	✓		W,O						S1[3]	S2[3]	Grassland (sparse), dredge spoil.
Western Meadowlark						✓			O						S4[3]	S4[3]	Grassland.
Western Bluebird									W,O						S3[3]	S4[3]	Riparian forest/ grassland mosaic.
Yellow Warbler						✓							✓				Forested wetlands, riparian forest, scrub-shrub.
Wilson's Warbler						✓											Forested wetlands, riparian forest, deciduous understory.
Hermit Warbler						✓									S4[3]		Riparian forest, forested wetland.
Winter Wren						✓											Riparian forest.
Purple Martin			So C[1]	SC[1]	SS[1]	✓			W,O						S3[3]	S2[3]	Forested wetlands, riparian forest, snags, open water.
Tree Swallow						✓											Forested wetlands, riparian forest – open water.
Vaux's Swift				SC[1]		✓			W						S3[3]		Forested wetland, riparian forest – hollow trees.
Pileated Woodpecker				SC[1]	SS[1]	✓			W						S4[3]		Forested wetland, riparian forest – large snags.
Downy Woodpecker						✓											Forested wetland, riparian forest.
Brown Creeper						✓											Forested wetland, riparian forest.
Red Crossbill						✓			O						S4[3]		Riparian forest, forested wetland (Sitka spruce).
Chinook Salmon	✓	✓	T[1], E[1]	SC[1]	SS[1]				W,O				✓			S2[3]	Open water and sloughs for migrating, tidal marsh for juvenile foraging.

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A.Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
Chum Salmon	✓	✓	T[1]	SC[1]	SS[1]				W,O				✓		S3[3]	S2[3]	Open water and sloughs for migrating, tidal marsh for juvenile foraging.
Coho Salmon	✓	✓	T[1]		SS[1]				W,O				✓		S3[3]	S2[3]	Open water and sloughs for migrating, tidal marsh for juvenile foraging.
Steelhead	✓	✓	T[1]	SC[1]	SS[1]				W,O				✓			S2[3]	Open water and sloughs for migrating, tidal marsh for juvenile foraging.
Coastal Cutthroat trout	✓		So C[1]		SS[1]				W,O				✓			S2[3]	Open water and sloughs, tidal marsh.
Bull Trout			T[1]	SC[1]	SS[1]				W,O				✓			S2[3]	Open water and sloughs.
White Sturgeon		✓											✓		S4[3]		Open water.
Pacific Lamprey			So C[1]		SS[1]				W,O				✓		S4[3]	S3[3]	Open water.
Red-legged Frog			So C[1]		SS[1]				O						S4[3]	S4[3]	Tidal and nontidal marsh, forested wetland, riparian forest, scrub-shrub.
Western Toad				SC[1]	SS[1]				W,O						S3[3]	S3[3]	Riparian forest, grassland, marsh.
Painted Turtle					SS[1]				O						S4[3]	S2[3]	Sloughs, nontidal marsh.
Valley Silverspot Butterfly				SC[1]					W						S2[3]		Grassland.
California Floater mollusk			So C[1]	SC[1]					W						S2[3]	S1[3]	River Bed.
Winged Floater mollusk									W								River Bed.
Oregon Floater mollusk									W						S3[3]	S3[3]	River Bed.
Sitka Spruce Swamp	✓	✓															
Cottonwood Tidal Swamp	✓	✓															
Scrub-shrub Tidal Swamp	✓	✓															
Riparian Forest	✓	✓															

SPECIES	Refuge Purpose	BIDEH [a]	Federally Listed	Washington Listed	Oregon Listed	Partners in Flight[b]	Birds of Conservation	Service Migratory Bird Focal Species[d]	State Comp. Wildlife Plan[e] (WA,OR)	Shorebird Plan[f] (priority score 4,5)	N.A.Waterbird Conservation Plan[g]	Pacific Flyway Management Plan[h]	Subbasin Plan[i]	NAWMP [j]	WA NHP[k]	OR NHP[l]	HABITAT TYPE
Tidal Marsh	✓	✓															

[1] T = Threatened; E = Endangered; SoC = Species of Concern; SC = State Candidate; SS = State Sensitive
[2]Category 4 = species of high concern
[3]S1 = critically imperiled; S2 = imperiled; S3 = rare, uncommon or threatened; S4 = not rare, apparently secure, but with cause for long-term concern
[a]U.S. Fish and Wildlife Service 2001
[b]Altman 1999, Altman 2000
[c]U.S. Fish and Wildlife Service 2002
[d]U.S. Fish and Wildlife Service 2005a
[e]Washington Dept. Fish and Wildlife 2005, Oregon Dept. Fish and Wildlife 2006
[f]Drut and Buchanan 2000
[g]Kushlan et al. 2002
[h]Subcommittee on Dusky Canada Geese 1992, Pacific Flyway Council 1999, Subcommittee on Pacific Population of Western Canada Geese 2000, Pacific Flyway Council 1983, Pacific Flyway Council 2001
[i]Northwest Power and Conservation Council 2004
[j]Oregon Habitat Joint Venture 1994 (North American Waterfowl Management Plan)
[k]Washington Natural Heritage Plan, State rankings (Washington Dept. of Natural Resources 2005)
[l]Oregon Natural Heritage Program, State rankings (Oregon Natural Heritage Program 2004)

Table 4-2a Summary of Biological Integrity, Diversity, and Environmental Health (BIDEH) for Julia Butler Hansen Refuge.

Species and Habitats (Plant Communities) that Represent Existing BIDEH	Population/Habitat Attributes (Age class, structure, seral stage, species composition)	Natural Processes Responsible for these Conditions	Landscape Limiting Factors
Columbian White-tailed Deer	Small population occupies habitat that is a mosaic of riparian forest, tidal forested wetland, tidal scrub-shrub, tidal and nontidal marsh, and upland grassland.	Flooding that maintained marsh, riparian forest and swamp habitat. Fire that maintained grassland openings in riparian forest.	Nonfunctioning flood plain: dike construction that led to industrial, agricultural and residential development, dam construction that reduced flooding, increased coyote numbers resulting from logging and land clearing, usurpation of former habitat by black-tailed deer.
Sitka Spruce Tidal Swamp (Palustrine Evergreen Forested Wetland)	Late succession forest, stand age greater than 95 years, with trees larger than 21 inches mean diameter at breast height (DBH). Western red cedar is also a common overstory tree. Abundant understory of native shrubs including willow, red-osier dogwood, nootka rose, and service berry.	Functioning floodplain with tidal flooding.	Nonfunctioning flood plain: dike construction that led to land clearing for industrial, agricultural, and residential development, dam construction that reduced flooding, invasive species such as reed canary grass that inhibit natural forest and shrub regrowth.
Cottonwood Tidal Swamp (Palustrine Deciduous Forested Wetland)	Mid to late succession forest with black cottonwood and Oregon ash as dominant canopy trees. Abundant understory of native shrubs including willow, red-osier dogwood, nootka rose, and red alder.		
Scrub-shrub Tidal Swamp (Palustrine scrub-shrub wetland)	Climax scrub-shrub vegetation with the major dominant being Sitka willow. Other dominants include Pacific willow, red-osier dogwood, and hardhack. Other species include ninebark, crab apple, and rose. Scattered Sitka spruce may be present.	Prolonged tidal flooding: elevation too low to permit growth of large trees.	Dike construction that led to land clearing for industrial, agricultural, and residential development, dam construction that reduced flooding, invasive species such as reed canary grass that inhibit natural forest and shrub regrowth.
Riparian Forest	Mid to late succession forest with the dominant trees being black cottonwood, red alder, Oregon ash, Sitka spruce, western red cedar, and bigleaf maple. Abundant understory of native shrubs including salmonberry, red-osier dogwood, willow, nine-bark, black hawthorn, snowberry, indian plum, and vine maple.	Natural forest growth and vegetation succession.	
Tidal Marsh (Palustrine and Estuarine Emergent Wetland)	Native emergent herbaceous marsh plants with a diversity of species including Lyngbye's sedge, pointed rush, tufted hairgrass, water parsnip, boltonia, water horsetail, wapato, spike rush, beggar-tick, soft stem bulrush, river bulrush, three-square bulrush, touch-me-not, and bird's-foot trefoil.	Prolonged tidal floods, elevation too low to permit woody plant growth, but there may be scattered willows.	Dike construction and drainage that prevent tidal flooding, invasive species such as reed canary grass and purple loosestrife that displace native vegetation.
Salmon (Chinook, Coho, Chum, Steelhead)	River channels provide migration pathways for adults traveling to spawning grounds throughout the Columbia River and Snake River basins, and for juveniles traveling to the Pacific Ocean. Tidal marshes, swamps, mudflats, and shallow waters produce forage organisms for juveniles.	Functioning floodplain, free flowing river, abundant productive tidal marshes and swamps.	Dams impede salmon migration, dike construction results in loss of productive marshes and swamps, and degradation of spawning streams throughout the basin has reduced salmon numbers.

Table 4-2b Summary of Biological Integrity, Diversity, and Environmental Health (BIDEH) for Lewis and Clark Refuge.

Species and Habitats (Plant Communities) that Represent Existing BIDEH	Population/Habitat Attributes (Age class, structure, seral stage, species composition)	Natural Processes Responsible for these Conditions	Landscape Limiting Factors
Salmon (Chinook, Coho, Chum, Steelhead)	River channels provide migration pathways for adults traveling to spawning grounds throughout the Columbia River and Snake River basins, and juveniles traveling to the Pacific. Tidal marshes, swamps, mudflats, and shallow waters produce forage organisms for juveniles.	Functioning floodplain, free flowing river, abundant productive tidal marshes, swamps, etc.	Dams impede salmon migration, dike construction results in loss of productive marshes and swamps; degradation of spawning streams throughout the basin has reduced salmon numbers.
Sitka Spruce Tidal Swamp (Palustrine Evergreen Forested Wetland)	Late succession forest, stand age greater than 95 years, with trees larger than 21 inches mean diameter at breast height (DBH). Western red cedar is also a common overstory tree. Abundant understory of native shrubs including willow, red-osier dogwood, nootka rose, and service berry.	Functioning floodplain with tidal flooding.	Nonfunctioning flood plain: dike construction that led to land clearing for industrial, agricultural, and residential development, dam construction that reduced flooding, invasive species such as reed canary grass that inhibit natural forest and shrub regrowth.
Cottonwood Tidal Swamp (Palustrine Deciduous Forested Wetland)	Mid to late succession forest with black cottonwood and Oregon ash as dominant canopy trees. Abundant understory of native shrubs including willow, red-osier dogwood, nootka rose, and red alder.		
Scrub-shrub Tidal Swamp (Palustrine scrub-shrub wetland)	Climax scrub-shrub vegetation with the major dominant being Sitka willow. Other dominants include Pacific willow, red-osier dogwood, and hardhack. Other species include ninebark, crab apple, and rose. Scattered Sitka spruce may be present.	Prolonged tidal flooding: elevation too low to permit growth of large trees.	Dike construction that led to land clearing for industrial, agricultural, and residential development, dam construction that reduced flooding, invasive species such as reed canary grass that inhibit natural forest and shrub regrowth.
Riparian Forest	Mid to late succession forest with the dominant trees being black cottonwood, red alder, Oregon ash, Sitka spruce, western red cedar, and bigleaf maple. Abundant understory of native shrubs including salmonberry, red-osier dogwood, willow, nine-bark, black hawthorn, snowberry, indian plum, and vine maple.	Natural forest growth and vegetation succession.	
Tidal Marsh (Palustrine and Estuarine Emergent Wetland)	Native emergent herbaceous marsh plants with a diversity of species including Lyngbye's sedge, pointed rush, tufted hairgrass, water parsnip, boltonia, water horsetail, wapato, spike rush, beggar-tick, soft stem bulrush, river bulrush, three-square bulrush, touch-me-not, and bird's-foot trefoil.	Prolonged tidal floods, elevation too low to permit woody plant growth, but there may be scattered willows.	Dike construction and drainage that prevent tidal flooding, invasive species such as reed canary grass and purple loosestrife that displace native vegetation.

Table 4-3a Priority Resources of Concern for Julia Butler Hansen Refuge.

Focal Species	Habitat Type	Habitat Structure	Life History Requirement	Other Benefiting Species[1]
Columbian White-tailed Deer	Grassland	Vegetation height of 4-6 inches during an average winter (Dec.-Feb.), field size smaller than 20 acres, with 20-40 percent clover, and 20 percent orchardgrass, within less than 820 feet of woodlots[2].	Foraging	Canada goose (other subspecies including western, lesser, and Vancouver), cackling goose, greater white-fronted goose, American wigeon, northern harrier, American kestrel, short-eared owl, western meadowlark, western bluebird, Wilson's snipe, killdeer, fringed myotis, long-eared myotis, and Yuma myotis.
Dusky Canada Goose		An average winter vegetation height of 4-6 inches, ryegrass preferred (greater than 30 percent), with small patch size (less than 100 acres)[3].	Wintering Foraging	
Swainson's Thrush Red-legged Frog Columbian White-tailed Deer*	Palustrine deciduous forested wetland – tidal cottonwood and/or willow swamp	Mid to late succession; abundant shrub layer cover (native species including red osier dogwood, salmonberry, trailing blackberry and, willows), greater than 50percent tree canopy closure (native species including black cottonwood, Oregon ash and willows)[2,4,6].	Foraging, Breeding	Fringed myotis, long-eared myotis, Yuma myotis, wood duck, Cooper's hawk, red-shouldered hawk, band-tailed pigeon, olive-sided flycatcher (forest edge), Pacific-slope flycatcher, red-eyed vireo, yellow warbler, rufous hummingbird, purple martin (snags), tree swallow (snags), great blue heron (nesting), pileated woodpecker, downy woodpecker, and brown creeper.
Bald Eagle Columbian White-tailed Deer* Red-legged Frog		Late succession: mature trees, within 5,000 feet of water and with an unobstructed view of a large water body[2,6,8,9].		
Little Willow Flycatcher Red-legged Frog Columbian White-tailed Deer*	Palustrine scrub-shrub wetland–tidal swamp	Predominantly shrubs (native species include Pacific willow, Sitka willow, Pacific nine-bark, hardhack, red osier dogwood), scattered larger trees (native species include Sitka spruce, black cotton-wood and willows) may be present[2,4,6].	Foraging, Breeding	Yellow warbler and rufous hummingbird.
Bald Eagle Red Crossbill Columbian White-tailed Deer* Red-legged Frog	Palustrine evergreen forested wetland – tidal Sitka spruce swamp	Late succession: mature trees, within 5,000 feet of water and with an unobstructed view of a large water body[2,8,9], with greater than 7 mature spruce trees per acre[2], typically with a dense understory of shrubs (Sitka willow, red osier dogwood).	Breeding, Foraging	Fringed myotis, long-eared myotis, Yuma myotis, wood duck, Cooper's hawk, red-shouldered hawk, olive-sided flycatcher (forest edge), Pacific-slope flycatcher, red-eyed vireo, yellow warbler, rufous hummingbird, purple martin (snags), tree swallow (snags), great blue heron (nesting), pileated wood-pecker, downy woodpecker, brown creeper, and red-legged frog.
Northern Pintail Columbian White-tailed Deer*	Palustrine emergent wetland-tidal	Shallow tidal marsh (less than 4-18 inches depth at mean higher tide stages), 30-70 percent cover of emergent vegetation,	Foraging	Mallard, wood duck, American wigeon, northern harrier, great blue heron, Cackling goose, dusky Canada goose, western Canada goose, tule greater

Focal Species	Habitat Type	Habitat Structure	Life History Requirement	Other Benefiting Species[1]
	marsh	native seed bearing plants such as bulrushes, spike rush, Lyngbye's sedge and smartweeds[2,7].		white-fronted goose, tundra swan, Wilson's snipe, bald eagle, and peregrine falcon.
Northern Pintail CWT deer *	Palustrine emergent wetland-nontidal freshwater marsh	Seasonally flooded shallow marsh, flooded to a depth of less than 4-18 inches from approximately October through June, with a 30-70 percent cover of emergent vegetation such as native seed bearing plants including spike rushes, bulrushes, manna grass, bur-reed, cattail and smartweeds [2,7].	Foraging (winter)	Mallard, wood duck, American wigeon, northern harrier, great blue heron, Cackling goose, dusky Canada goose, western Canada goose, tule greater white-fronted goose, tundra swan, Wilson's snipe, western painted turtle.
Red-legged Frog		Shallow water (1.5-6.5 feet) with emergent and/or submergent vegetation[6].	Breeding	
CWT deer * Red-legged Frog Yellow Warbler Swainson's Thrush	Riparian forest and shrub	Mid succession multilayered, varied forest with abundant shrubs and subcanopy trees, in addition to larger canopy trees. Native species including red alder, black cottonwood, Sitka spruce, red cedar, red-osier dogwood, nine-bark, salmonberry, and willows [2,4,6].	Breeding, Foraging	Roosevelt elk, Yuma bat, fringed myotis, long-eared myotis, white-footed vole, wood duck, red-shouldered hawk, Cooper's hawk, band-tailed pigeon, northern saw-whet owl, western screech owl, olive-sided flycatcher (forest edge), red-eyed vireo, rufous hummingbird, purple martin (snags), tree swallow, pileated woodpecker, downy woodpecker, and brown creeper.
Little Willow Flycatcher Red-legged Frog CWT Deer*		Early succession; shrubs and young trees, native species including red osier dogwood, salmonberry, trailing blackberry, willows, Sitka spruce, black cottonwood, red alder, red cedar[2,4,6], early-successional stands on the refuge are usually the result of planting trees and shrubs.	Breeding, Foraging	Roosevelt elk, yellow warbler, and rufous hummingbird.
Bald Eagle Swainson's Thrush CWT Deer* Red-legged Frog		Late succession: mature trees, abundant shrubs in openings, within 5,000 feet of water, with an unobstructed view of a large water body[2,4,6,8,9], native trees and shrubs including Sitka spruce, red cedar, red alder, black cottonwood, salmonberry, red osier dogwood, trailing blackberry, and willows.	Breeding, Foraging	Roosevelt elk, fringed myotis, long-eared myotis, Yuma myotis, red-shouldered hawk, Cooper's hawk, Vaux's swift (snags), tree swallow, purple martin (snags), olive-sided flycatcher (forest edge), and rufous hummingbird.
Chinook salmon (juvenile)	Riverine open water sloughs (River back-waters either	Current less than 0.3 feet per second for refuge from strong currents, aquatic vegetation for shelter from predatory fish.[10]	Foraging, Resting	Red-legged frog, painted turtle, coho salmon, chum salmon, steelhead, coastal cutthroat trout, Oregon floater, winged floater, lesser scaup, greater scaup, bald eagle, purple martin, and tree swallow

Focal Species	Habitat Type	Habitat Structure	Life History Requirement	Other Benefiting Species[1]
	restricted by tidegates or not).			
California Floater	Riverine unconsolidated bottom	Sand or mud bottom substrate[11]	Breeding, Foraging	

*The CWT deer is a habitat generalist in its use of shrub, forest and marsh. A modest degree of canopy closure for cover; abundant shrubs for cover and forage; and tree lichens, grasses and forbs for forage satisfy its forest requirements. An abundance of marsh grasses and forbs provide forage. Therefore, the detailed habitat structures given for birds in this table would also benefit CWT deer. The ideal habitat for the deer is a mosaic of small forest stands, short grass fields, and seasonal or tidal marsh.

[1]from table 4-1.A, Comprehensive List of Resources of Concern
[2]Suring and Vohs, Jr., 1979
[3]Bromley and Rothe 2003
[4]Altman 2000
[5]Altman 1999
[6]Corkran and Thoms 1996
[7]Fredrickson and Heitmeyer 1991
[8]Anthony et.al.1982
[9]Buehler 2000
[10]Johnson et.al. 2003
[11]Nedeau et.al. *undated*

Table 4-3b Priority Resources of Concern for Lewis and Clark Refuge.

Focal Species	Habitat Type	Habitat Structure	Life History Requirement	Other Benefiting Species[1]
Chinook Salmon	Riverine and estuarine open water and unconsolidated bottom	Medium to deep depths (elevations between 3 and greater than 18 feet below MLLW)[2,3]	Migrating	Steller sea lion, coho salmon, chum salmon, steelhead, coastal cutthroat trout, white sturgeon, and bull trout.
Greater Scaup Western Grebe		Shallow to medium depth (3-30 feet), fine soft bottom substrates of silt or sand[3,17]	Wintering, Foraging	Lesser scaup, double-crested cormorant, purple martin (foraging), tree swallow (foraging), California floater mollusk, winged floater mollusk, coho salmon, chum salmon, steelhead, coastal cutthroat trout, white sturgeon, and bull trout.
Oregon Floater			Breeding, Foraging	
Chinook Salmon (juvenile)		Shallows and flats (elevations between MLLW and about 6 feet below MLLW), vegetation is absent[2,3]	Foraging, Migrating	
Caspian Tern		Shallow depth (1-16 feet preferred, but sometimes deeper)[16]	Foraging	
Western Sandpiper	Riverine and estuarine unconsolidated shore-tidal flats (mud flats) and sandbars	Largely unvegetated flats with soft substrates and benthic invertebrates[5,6]	Migrating	Peregrine falcon, merlin, dunlin, killdeer, greater yellowlegs
Steller Sea Lion		Sand bars for haulout sites	Resting	
Mallard Northern Pintail	Estuarine and palustrine emergent wetland-tidal marsh	Water depth less than 10 inches, native emergent seed bearing vegetation including soft-stem bulrush, Lyngbye's sedge and smartweed[10,12]	Migrating, Wintering	Peregrine falcon, merlin, northern harrier, cackling goose, dusky Canada goose, western Canada goose, tule greater white-fronted goose, wood duck, American wigeon, purple martin (foraging), tree swallow (foraging), Wilson's snipe, greater yellowlegs, and CWT deer (foraging)
Tundra Swan		Water depth to 3 feet, native emergent and submergent vegetation (wapato, sedges, rushes) to provide seeds, stems, roots and tubers[13]	Wintering	
Chinook Salmon (juvenile)		Elevations between MLLW and slightly above MHHW dominated by herbaceous emergent vegetation and low shrubs, often includes tidal channels[2,3]	Foraging	
Little Willow Flycatcher	Palustrine scrub-shrub wetland–tidal swamp	Early succession; shrub layer (less than 13 feet) 30-80 percent cover (native species including red osier dogwood, salmonberry, trailing blackberry, willows), canopy tree (greater than 13 feet tall) cover less than 20 percent (native species including sitka spruce, black cottonwood, willows)[4]	Nesting, Foraging	Yellow warbler and CWT deer.
Bald Eagle	Palustrine evergreen and deciduous forested	Late succession: mature trees with mean DBH greater than 41 inches, within 5,000 feet of water and with an unobstructed view of a large water body[7,11]	Nesting, Perching	CWT deer, Yuma bat, Townsend's big-eared bat, wood duck, red-shouldered hawk, Cooper's hawk, merlin, band-tailed pigeon, northern saw-whet owl,

Focal Species	Habitat Type	Habitat Structure	Life History Requirement	Other Benefiting Species[1]
Red Crossbill	wetland–tidal Sitka spruce or cottonwood/willow swamp	Late succession forest with more than 7 mature spruce trees per acre.[8]	Foraging	western screech owl, olive-sided flycatcher (forest edge), red-eyed vireo, Swainson's thrush rufous humming-bird, purple martin (snags), tree swallow, pileated woodpecker, downy woodpecker, brown creeper
Streaked Horned Lark	Upland dredge spoil islands with sparse vegetation	Sparsely vegetated (~35 percent of ground unvegetated) sandy areas, dominated by grasses and forbs with few or no trees or shrubs[9]	Foraging, Breeding	Double-crested cormorant (nesting), killdeer
Caspian Tern		Open, sparsely vegetated areas on islands or areas free of mammalian predators, sand substrate preferred[14,15,16]	Breeding	
Bald Eagle	Upland and riparian conifer and mixed forest	Late succession: mature trees with mean dbh greater than 41 inches, within 5,000 feet of water and with an unobstructed view of a large water body[7,11]	Breeding	Vaux's swift (snags), brown creeper, pileated woodpecker, downy woodpecker, hermit warbler, Pacific-slope flycatcher, Hammond's flycatcher, Wilson's warbler, winter wren, red-shouldered hawk, Cooper's hawk, northern saw-whet owl, western screech owl, Townsend's big-eared bat, Yuma bat
Varied Thrush		Late succession forest in blocks larger than 75 acres, canopy closure greater than 70 percent and deciduous vegetative cover greater than 30 percent in the subcanopy[8]	Breeding, Foraging	
Red Crossbill		Late succession forest with more than 7 conifer trees per acre larger than 18 inches dbh with more than 2 trees larger than 24 inches dbh.[8]	Foraging	

[1]from Table 4-1b, Comprehensive List of Resources of Concern
[2]Johnson et al. 2003
[3]Thomas 1983
[4]Altman 2000
[5]Wilson 1994
[6]Paulson 1993
[7]Anthony et al. 1982
[8]Altman 1999
[9]Pearson Hopey 2005
[10]Laubhan and Fredrickson 1993
[11]Buehler 2000
[12]Fredrickson and Heitmeyer 1991
[13]Limpert and Earnst 1994
[14]Quinn and Sirdevan. 1998
[15]Penland 1976
[16]Cuthbert and Wires 1999
[17]Nedeau et al. *Undated*

4.3 Habitats and Vegetation

The refuges are located within the Sitka spruce vegetation zone (Franklin and Dyrness 1988). Prior to settlement and development, the land was a mix of tidal marsh, Sitka spruce tidal swamp, black cottonwood tidal swamp, and willow scrub-shrub tidal swamp. These habitats remain, although their acreage has been reduced. Diking, drainage and land clearing has converted some former tidal marsh/swamp habitat to upland grassland and riparian forest.

The current refuge habitats were mapped using GIS based on the interpretation and analysis of 2003 color infrared and 2005 true color ortho-corrected aerial photography. These habitats are depicted in Maps 4a, 4b, and 6 and the acreages of each are shown in Table 4-4.

Table 4-4 Habitat Types and Acreages within Lewis and Clark and Julia Butler Hansen Refuges.

Habitat	Number of Acres		
	Lewis and Clark Refuge	Julia Butler Hansen Refuge	Total
Riverine and Estuarine Open Water (sum of Unconsolidated Bottom and Ditches)	1,362	296	1,658
Riverine and Estuarine Unconsolidated Shore (Tidal Flats and Sandbars)*	4,825	63	4,888
Riverine and Estuarine Unconsolidated Bottom (River/Slough Bottom)*	1,362	249	1,611
Estuarine and Palustrine Emergent Wetland-Tidal Marsh	3,723	301	4,024
Palustrine Scrub-Shrub Tidal Wetland	2,165	847	3,012
Palustrine Evergreen Forested Wetland–Tidal Sitka Spruce Swamp	284	353	637
Palustrine Deciduous Forested Wetland–Tidal Cottonwood Willow Swamp	120	611	731
Palustrine Emergent Wetland–Nontidal Marsh	0	129	129
Riparian Forest and Shrub	469	924	1,393
Grassland	68	2,384	2,452
Barren Land-Upland Dredge Spoil with Sparse Vegetation	16	7	23
Upland Conifer and Mixed forest	89	0	89
Low Intensity Developed	0.32	74	74.32
Ditch	0	48	48

*Overlaps with open water, i.e., open water includes both unconsolidated bottom (river and slough bottoms) and ditches.

The following summaries of habitats and vegetative communities are based largely on descriptions by Christy (2004), Christy and Putera (1992), Cowardin et al. (1979), Thomas (1980, 1983), and Tabor (1976), along with the observations of refuge staff. The plant and animal species listed in this section are given as examples of the more common species present, not as a comprehensive list of all species present.

4.3.1 Riverine and Estuarine Open Water and Unconsolidated Bottom

Open water refers to those areas that are continuously submerged. The elevation is generally 6 feet or more below mean lower low water. These habitats are referred to as deepwater habitats by Cowardin et al. (1979). Only fully aquatic organisms reside in the open water.

The open water channels of the river are home to fish and a variety of invertebrate animals and aquatic plants. They serve as migration pathways for adult salmon, shad, eulachon, lamprey, and steelhead going upriver to spawn, as well as for the juveniles going downstream to the ocean. Deeper channels and holes are preferred habitat for white sturgeon. Clams, mussels, aquatic worms, and other small organisms are found on the bottom. Rooted aquatic plants are scarce in the main channels because of water depth and strong, erosive, currents, but are found in backwaters.

Julia Butler Hansen Refuge has over 200 acres of Columbia River backwaters, or sloughs. The sloughs on the mainland and Tenasillahe Island were cut off from the river when the dikes were constructed. Some of the sloughs have tidegates that allow water to pass directly to the river. Other sloughs drain through ditches that connect to sloughs with tidegates. These diked sloughs have very slow current velocities because of the constricting effect of the tidegates. Water temperatures in the summer are much higher in the sloughs than water temperatures in the Columbia River. Partly because of these differences, nonnative species of plants and fish are predominant. Parrotfeather milfoil covers the water surface in many areas. Introduced species of fish such as common carp, largemouth bass, yellow perch, and bluegill are abundant.

Sloughs on the undiked islands are usually open to the river at only one end (at least at normal water levels), so that current velocities are much lower than the river channels. Vegetation is generally scarce, due to the slough's steep sides and depth. Invertebrate organisms are plentiful. Juvenile salmonids use the sloughs to forage and gain respite from strong currents.

4.3.2 Riverine and Estuarine Unconsolidated Shore (Tidal Flats and Sandbars)

Tidal flats and sandbars are those areas that are often submerged, but are exposed at lower tide levels. The elevation is less than 6 feet below mean lower low water. Typically, vegetation is scarce or absent. These areas support an abundance of invertebrates including clams, mussels, amphipods, polychaete and oligochaete worms, and nematodes. Foraging shorebirds follow the receding tide across the flats, and fish and scaup frequent the flats when they are flooded.

4.3.3 Estuarine and Palustrine Emergent Wetland–Tidal Marsh

Tidal marsh occurs in the estuary where the ground is high enough (not flooded too deeply for too long) to support emergent herbaceous plants, but too low and wet to support shrubs or trees. They are generally found from elevations of about mean lower low water to mean higher high water. There is no saltwater intrusion into the Julia Butler Hansen Refuge and relatively little into the Lewis and Clark Refuge, thus the refuge's tidal marshes are characterized by freshwater marsh plants (Thomas 1980).

The lowest elevation marshes feature pioneering plants such as soft-stem bulrush, pointed rush, spike rush, river bulrush, and wapato. At medium elevations, Lyngbye's sedge, tufted hairgrass, water horsetail, water parsnip, boltonia, monkeyflower, marsh marigold, beggar-ticks, water plantain, and willow-herb appear. Plant diversity continues to increase as the elevation rises. Douglas' aster, reed canarygrass, tall fescue, sneezeweed, birds-foot trefoil, Pacific silverweed, skunk cabbage, forget-me-not, slough sedge, smartweed, rice cut-grass, scattered willows, and other species join the mix of plants at the higher elevations.

These marshes provide an abundance of food for the invertebrates, fish, birds, and mammals of the estuary. The vegetation filters pollutants from the water. The plant seeds, roots, tubers, and leaves feed many thousands of ducks and geese. Bits and decaying remains of plants are fed upon by small organisms called detritivores, which in turn are fed upon by larger organisms. Juvenile salmon and other fish find an abundance of food in the marshes, as well as shelter from strong currents and predators. Bald eagles, great blue herons, and other predators are attracted to the abundance of life. The productivity of the marshes is critical to the health of the estuary.

Over the past century, the extent of tidal marsh in the lower estuary declined from about 16,000 acres to about 9,000 acres. Most of this loss occurred in the first half of the 20th century when extensive areas of former tidal wetlands were surrounded with dikes and converted to agricultural land.

4.3.4 Palustrine Tidal Scrub-Shrub Wetland

Scrub-shrub wetlands, or swamps, occur at elevations that are just high enough to support woody plants, but too low and too frequently submerged to support large trees. Scrub-shrub wetlands usually occur from about mean higher high water to slightly above. With an extent of 2,165 acres, scrub-shrub is the second most widespread terrestrial habitat type on the Lewis and Clark Refuge.

The scrub-shrub often forms nearly impenetrable thickets. Sitka willow is usually the dominant species, although spiraea (hardhack) is dominant in some areas. Other shrub species include Pacific willow, red-osier dogwood, nine-bark, crab apple, and Nootka rose. Twinberry and serviceberry occur in places. Herbaceous understory plants include skunk cabbage, jewelweed, water horsetail, and slough sedge. Scattered Sitka spruce and cottonwood trees may also be present. Scrub-shrub is often interspersed with Sitka spruce or black cottonwood tidal forested swamp. The spruce and/or cottonwood grow on the natural levees that form along the edges of islands and bisecting channels, and the scrub-shrub occupies the lower interior areas.

As with the marshes, the scrub-shrub provides nutrients for the estuary food chain. Dead leaves, branches, and shrubs feed detritivores, which in turn feed fish and other organisms. Juvenile salmon and other fish find food and shelter from strong currents in the web of narrow channels that wind through the shrubs. Passerine birds such as willow flycatchers and yellow warblers forage and nest in the willows. Ducks feed on invertebrates and herbaceous plant seeds during high tides. Beaver eat the bark of the willows.

Of all the estuary's habitats, the tidal swamps (scrub-shrub, cottonwood, and Sitka spruce) have sustained the greatest losses due to the construction of dikes. The acreage covered by swamps in the lower estuary declined from 30,000 in 1870 to 7,000 today (Thomas 1983).

4.3.5 Palustrine Evergreen Forested Tidal Wetland–Sitka Spruce Swamp

The Sitka spruce zone extends from about the Chinook River to Puget Island. The spruce swamps occur at elevations slightly higher than scrub-shrub swamps—generally above mean higher high water.

Sitka spruce is the dominant tree. There may also be scattered western red cedar, red alder, cottonwood, and Oregon ash. Scrub-shrub forms a dense understory. Shrub species include Sitka willow, Pacific willow, red-osier dogwood, crabapple, rose, snowberry, and salmonberry. Areas of pure scrub-shrub are often intermixed with the spruce stands. Herbaceous ground cover plants include skunk cabbage, slough sedge, maidenhair fern, and jewelweed.

Columbian white-tailed deer are often found in the spruce swamps. They can escape high water on the hummocks formed from large trees that fell long ago. The spruce swamp supports a high diversity of birds and small mammals. Red crossbills forage on the cones. Woodpeckers (hairy, downy, and pileated), Stellar's jay, tree swallow, black-capped chickadee, winter wren, hermit thrush, Swainson's thrush, golden-crowned kinglets, cedar waxwing, and song sparrow are common residents of the swamps. Colonies of great blue herons nest in the trees. Deer mice and vagrant shrews live in the branches. Otter and beaver cruise the channels. Fallen leaves, branches and trees provide nutrients that feed the estuary.

Spruce swamps originally covered about 19,000 acres of the estuary. Only about 2,200 acres remain (Christy and Putera 1992). The 637 acres of spruce swamps on the refuges are a significant contribution to the preservation of this rare habitat that is underrepresented in the Columbia River estuary.

4.3.6 Palustrine Deciduous Forested Tidal Wetland–Cottonwood/Willow Swamp

As the elevation rises, cottonwood swamps become prevalent. Black cottonwood becomes the dominant tree in the swamps near Cathlamet and upstream. Oregon ash is also commonly present, and may be codominant. Other tree species may include Sitka spruce, red alder, and willow. Understory characteristics vary according to elevation, wetness, age of the stand, and other site factors. Old growth stands with considerable tidal flooding often have a dense understory, similar to the spruce swamps, and may be intermixed with Sitka willow/Pacific willow/red-osier dogwood scrub-shrub. Younger, more vigorous, stands in somewhat drier sites may achieve complete canopy closure. The resultant shading leads to a sparse understory of diverse shrubs including willows, red-osier dogwood, salmonberry, rose, and snowberry. Trailing blackberry often forms a ground cover in these stands. A wide variety of other herbaceous plants are typically present. At some sites, reed canarygrass is prevalent.

The cottonwood swamps, like the spruce swamps, host an abundance and diversity of wildlife. The wood of cottonwood is soft and rots quickly, creating ideal habitat for cavity nesting birds. Hairy and downy woodpeckers and red-bellied sapsuckers bore nesting cavities in the soft wood. Wood ducks and hooded mergansers utilize natural cavities. Passerine birds, such as black-throated gray warblers and warbling vireos, are abundant. The uncommon red-eyed vireo frequents the swamps. Cottonwood bark is a favorite food of beavers. Columbian white-tailed deer, black-tailed deer, raccoons, river otters, mink, deer mice, vagrant shrews, and other mammals find food and cover. Great blue herons nest in colonies in the trees. Salmon and other fish benefit from the nutrients that flow from the swamps. Red-legged frogs and Pacific treefrogs forage on insects and breed in vernal pools.

The cottonwood swamps share with the spruce swamps the distinction of being one of the habitat types most impacted dike construction, river flow regulation/alternation from dams, and land clearing for agriculture and development. It is safe to say that the remaining cottonwood swamps are a small fragment of what existed when Lewis and Clark journeyed here.

4.3.7 Palustrine Emergent Wetland–Nontidal Marsh

Nontidal marshes on the refuges have no direct connection to the Columbia River and thus are not affected, or are affected very little, by the tides. These marshes occur primarily on the diked areas of the Julia Butler Hansen Refuge (the Mainland and Tenasillahe Island units). They are seasonal in nature and form in depressions where winter rainfall creates pools.

The nontidal marshes tend to be small in size and vegetated with undesirable invasive plants such as reed canarygrass and common rush (tussock). Since 1999, the refuge has been enhancing some of these marshes by shallow excavation and the installation of water control structures. To date, 20 areas totaling 129 acres have been improved. The excavation and water control installations result in establishing more desirable wetland plants. Species include creeping spike rush, cat-tail, bur-reed, smartweed, beggar-ticks, soft-stem bulrush, water purslane, tapered rush, water foxtail, wapato, mannagrass, and water plantain. Less desirable plants such as reed canarygrass and common rush also flourish and are periodically controlled by mowing and cultivating.

The nontidal marshes have many of the same biological functions as the tidal marshes that were present prior to the construction of dikes. The plants provide food for thousands of migratory ducks and geese. Bald eagles and peregrine falcons are attracted to the abundance of prey. Water draining from the marshes carries nutrients that reach the Columbia River and help feed the organisms of the estuary, including salmon. Columbian white-tailed deer feed on water foxtail and other marsh plants. The nontidal marshes also provide ideal breeding habitat for several species of amphibians, such as long-toed salamanders, red-legged frogs, and Pacific treefrogs.

4.3.8 Riparian Forest and Shrub

Riparian forest and shrub habitat is dominated by woody vegetation that lies adjacent to a stream, channel, seep, or other body of flowing water. It is typically within or very close to the flood

plain of a stream and the vegetative composition is influenced by moist soils. For the purpose of this CCP, the term riparian forest refers to woodlands that are along the estuary, they are not swamps, and they are not flooded with consistent regularity. Riparian shrub is a transition habitat that will soon mature into riparian forest. These definitions include nearly all wooded habitats (other than swamps) on the refuges.

At the Julia Butler Hansen Refuge, riparian forest/shrub habitat is found primarily on the diked areas of the Mainland and Tenasillahe Island units, although a small amount occurs on the highest parts of Crims and Price Islands. Within the Lewis and Clark Refuge, riparian forest occurs on the higher ground of old dredge spoil islands including Miller Sands, Lois, and Mott Islands, and on Tongue Point.

Riparian forest within the diked areas is characterized by a diverse mix of tree species. Cottonwood, red alder, Sitka spruce, western red cedar, big-leaf maple, Oregon ash, and tree-sized willows are prominent. Understory shrubs include salmonberry, red-osier dogwood, snowberry, red elderberry, trailing blackberry, and currant. Riparian forests on the undiked river islands tend be less diverse, with cottonwood (downstream islands) and cottonwood/Willow/Oregon ash (upstream islands) being the dominant tree species.

Riparian forests typically support a diversity of plants and are structurally complex (Pollock 1998). They also support a great diversity and abundance of wildlife. Red-eyed vireos, uncommon in Washington, nest and forage in the trees along with downy woodpeckers, Swainson's thrushes, and Cooper's hawks. The shrub understory is a favorite habitat of yellow warblers, among other species. Winter wrens, red-legged frogs, and northwestern salamanders forage on the forest floor. Columbian white-tailed deer find browse and cover. The trees shade waterways, thus improving water quality for salmon and other fish. A large amount of the organic matter produced by the forest finds it way to the estuary, where it nourishes the food chain.

4.3.9 Grassland

Grasslands occupy 2,384 acres on the Julia Butler Hansen Refuge and 68 acres on the Lewis and Clark Refuge. Grasslands are not native habitats of the refuges; rather, they were created when dikes were constructed and former marsh and swamp habitat was cleared and drained for agriculture. The grasslands are dominated by introduced varieties of grasses that were originally planted for livestock forage. Species include tall fescue, reed canarygrass, orchardgrass, velvetgrass, meadow foxtail, ryegrass, and bentgrasses. Other plants that are common in the grasslands include red and white clover, creeping buttercup, field horsetail, curly dock, and common rush (tussock).

Grassland management is a major activity at Julia Butler Hansen Refuge. Cattle grazing, mowing, and seeding are used to maintain about 700 acres in short, actively growing, nutritious grasses and clover that provide high quality forage for CWT deer, Canada geese, and cackling geese. Unmanaged grasslands tend to be dominated by reed canarygrass, and to a lesser extent, tall fescue. In wetter areas, common rush (tussock) may form dense stands.

While the grasslands are managed primarily to benefit CWT deer and geese, other wildlife also utilize them. Townsend's voles flourish in the grass and their presence attracts predators such as northern harriers, white-tailed kites, great horned owls, barn owls, coyotes, long-tailed weasels, and garter snakes. Other species that utilize the grasslands include Wilson's snipe, western meadowlark, American kestrel, tree swallow, barn swallow, purple martin, Virginia rail, yellowthroat, and American wigeon.

4.3.10 Barren Land–Upland Dredge Spoil Islands

The approved boundary of the Lewis and Clark Refuge includes six islands that were created by the deposition of sandy material dredged from the river's bottom during ship channel maintenance operations. The islands are Pillar Rock (Jim Crow Sands), Miller Sands, Miller Sands Spit, Rice, Mott, and Lois. Miller Sands, Mott, and Lois Islands have not been used for spoil deposition for many years and are now heavily vegetated with riparian cottonwood forest and scrub-shrub.

Pillar Rock, Miller Sands Spit, and Rice Islands are used regularly for spoil deposition and are characterized by large expanses of bare, sandy ground with areas of sparse grasses, forbs, and small shrubs. These islands are a unique, almost desert-like habitat in the estuary. The lack of vegetation and absence of mammalian predators make the islands an attractive nesting location for colonial waterbirds such as glaucous-winged and western gulls, Caspian terns, and double-crested cormorants. Canada geese also nest on the spoil islands. The rare streaked horned lark is fairly common here.

The off-channel edges of the spoil islands often slope into shrubby willows and cottonwoods near the water's edge, and then into tidal marsh and shallow flats. These shallows attract large numbers of wintering ducks, as well as migrating shorebirds and juvenile salmon.

4.3.11 Upland Conifer and Mixed Forest

The only upland forest habitat within the refuges occurs on the 89-acre Emerald Heights Unit of the Lewis and Clark Refuge. Upland forest occurs at elevations ranging from 50 to 266 feet. The Emerald Heights Unit is completely forested, with 120 year-old western hemlock being the dominant species. Sitka spruce are scattered throughout the stand. The southwest part of the unit contains a small amount of 65 year-old western hemlock, Sitka spruce, Douglas fir, and red alder. A bald eagle nest site is located within the forest. The forest also provides high quality habitat for passerine birds, including pileated woodpeckers, varied thrushes, hermit warblers, Hammond's flycatchers, Wilson's warblers, and winter wrens.

4.4 Fish and Wildlife

4.4.1 Fish

The Columbia River estuary provides habitat for a relatively large number of freshwater and marine fish species. During February 1980 through July 1981, NOAA's Fisheries Service conducted monthly fish surveys throughout the estuary, from marine habitats near the Columbia

River mouth to completely freshwater habitats 38 miles upstream. A total of 75 fish species were collected (Table 4-5) from three regions of the estuary. The regions were selected based on salinity, marine/estuarine mixing, and freshwater (Bottom et al. 1984). An additional five species have been collected in recent surveys at both refuges by the Service and USGS (USFWS unpublished data; Haskell et al. 2005a,b). Of the 80 fish species collected, approximately half were collected in the completely freshwater region in which the refuges occur.

Table 4-5 Species of Fish Collected in the Columbia River Estuary.

Common Name	Scientific Name
River lamprey	*Lampetra ayresi*[1]
Western brook lamprey	*Lampetra richardsoni*[2]
Pacific lamprey	*Lampetra tridentata*[1]
Spiny dogfish	*Squalus acanthias*[1]
Big skate	*Raja binoculata*[1]
Green sturgeon	*Acipenser medirostris*[1]
White sturgeon	*Acipenser transmontanus*[1]
American shad	*Alosa sapidissima*[1]
Pacific herring	*Clupea pallasi*[1]
Northern anchovy	*Engraulis mordax*[1]
Common carp	*Cyprinus carpio*[1]
Peamouth	*Mylocheilus caurinus*[1]
Northern pikeminnow	*Ptychocheilus oregonensis*[1]
Largescale sucker	*Catostomus macrocheilus*[1]
Yellow bullhead	*Ameiurus natalis*[1]
Brown bullhead	*Ameiurus nebulosus*[1]
Whitebait smelt	*Allosmerus elongatus*[1]
Surf smelt	*Hypomesus pretiosus*[1]
Night smelt	*Spirinchus starksi*[1]
Longfin smelt	*Spirinchus thaleichthys*[1]
Eulachon	*Thaleichthys pacificus*[1]
Cutthroat trout	*Oncorhynchus clarki*[1]
Chum salmon	*Oncorhynchus keta*[1]
Coho salmon	*Oncorhynchus kisutch*[1]
Steelhead	*Oncorhynchus mykiss*[1]
Sockeye salmon	*Oncorhynchus nerka*[1]
Chinook salmon	*Oncorhynchus tshawytscha*[1]
Mountain whitefish	*Prosopium williamsoni*[1]
Pacific hake	*Merluccius productus*[1]
Pacific tomcod	*Microgadus proximus*[1]
Walleye Pollock	*Theragra chalcogramma*[1]
Banded killifish	*Fundulus diaphanus*[2]
Western mosquitofish	*Gambusia affinis*[3]
Threespine stickleback	*Gasterosteus aculeatus*[1]
Bay pipefish	*Syngnathus leptorhynchus*[1]
Black rockfish	*Sebastes melanops*[1]
Kelp greenling	*Hexagrammos decagrammus*[1]
Lingcod	*Ophiodon elongatus*[1]
Padded sculpin	*Artedius fenestralis*[1]
Coastrange sculpin	*Cottus aleuticus*[1]
Prickly sculpin	*Cottus asper*[1]
Mottled sculpin	*Cottus bairdi*[3]
Buffalo sculpin	*Enophyrs bison*[1]
Red Irish lord	*Hemilcpidotus hemilepidotus*[1]
Pacific staghorn sculpin	*Leptocottus armatus*[1]

Common Name	Scientific Name
Cabezon	*Scorpaenichthys marmoratus*[1]
Warty poacher	*Ocella varrucosa*[1]
Tubenose poacher	*Pallasina barbata*[1]
Pricklebreast poacher	*Stellerina xyosterna*[1]
Slipskin snailfish	*Liparis fucensis*[1]
Showy snailfish	*Liparis pulchellus*[1]
Ringtail snailfish	*Liparis rutteri*[1]
Pumpkinseed	*Lepomis gibbosus*[1]
Warmouth	*Lepomis gulosus*[1]
Bluegill	*Lepomis macrochirus*[1]
Smallmouth bass	*Micropterus dolomieu*[2]
Largemouth bass	*Micropterus salmoides*[1]
White crappie	*Pomoxis annularis*[1]
Black crappie	*Pomoxis nigromaculatus*[1]
Yellow perch	*Perca flavescens*[1]
Redtail surfperch	*Amphistichus rhodoterus*[1]
Shiner perch	*Cymatogaster aggregata*[1]
Striped seaperch	*Embiotoca lateralis*[1]
Spotfin surfperch	*Hyperprosopon anale*[1]
Walleye surfperch	*Hlyperprosopon argenteum*[1]
Silver surfperch	*Hyperprosopon ellipticum*[1]
White seaperch	*Phanerodon furcatus*[1]
Pile perch	*Rhacochilus vacca*[1]
Snake prickleback	*Lumpenus sagitta*[1]
Saddleback gunnel	*Pholis ornata*[1]
Pacific sand lance	*Ammodytes hexapterus*[1]
Pacific sandfish	*Trichodon trichodon*[1]
Bay goby	*Lepidogobius lepidus*[1]
Pacific sanddab	*Citharichthys sordidus*[1]
Speckled sanddab	*Citharichthys stigmaeus*[1]
Starry flounder	*Platichthys stellatus*[1]
Butter sole	*Pleuronectes isolepis*[1]
English sole	*Pleuronecte vetulus*[1]
C-O sole	*Pleuronichthys coenosus*[1]
Sand sole	*Psettichthys melanostic*[1]

[1] Bottom et al. 1984
[2] Johnson et al. 2009
[3] Haskell et al. 2005a, b; not reported in Bottom et al. 1984 or Johnson et al. 2009

4.4.1.1 Salmon

Fish most identified with the Columbia River are anadromous salmonids. Salmonids found in the lower Columbia River include Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), sockeye salmon (*O. nerka*), steelhead (*O. mykiss*), coastal cutthroat trout (*O. clarki clarki*), and pink salmon (*O. gorbuscha*), however, pink salmon rarely spawn in the Columbia River basin (Wydoski and Whitney 2003). Although life histories vary considerably among and within the five species of Pacific salmon (Groot and Margolis 1991), the general life cycle for Pacific salmon consists of adults spawning in freshwater and subsequently dying, egg development, juvenile rearing, juvenile migration to saltwater, growth and maturation in saltwater, and adult migration to freshwater spawning habitats (NRC 1996). Adult salmon primarily spawn in the fall, however, the season that Chinook salmon return to freshwater prior to spawning is used to describe specific runs—fall-, spring-, and summer-runs.

Two life histories of Chinook salmon, stream- and ocean-type, are also distinguished by the residency of juveniles in freshwater (Healey 1991: NRC 1996; Bottom et al. 2005; Fresh et al. 2005). Stream-type fish spend one to two years in streams and rivers prior to migrating to saltwater, whereas ocean-type fish migrate in their first year after up to a few months in streams or rivers. Ocean-type fish also rear in lower reaches of rivers and estuaries much more than stream-type fish. The other species of Pacific salmon, juvenile chum and pink salmon, migrate to saltwater either immediately or within a few weeks after emergence, coho salmon generally spend a year rearing in freshwater before migrating, and sockeye salmon typically spend a year rearing in a lake before migrating (NRC 1996).

Steelhead and coastal cutthroat trout exhibit substantial variability in their life histories (Behnke 1992; Burgner et al. 1992; Hall et al. 1997). Both species spawn from late winter through the spring. Adult steelhead that return to freshwater fully mature from late fall through spring are considered winter-run fish, whereas those that are sexually undeveloped and return from late spring through early fall are considered summer-run fish (Withler 1966). Anadromous individuals of both species may spend one to six years in freshwater with most migrating after at least two years (Burgner et al. 1992; Trotter 1997). Steelhead migrate to the open ocean and spend one to four years before returning to spawn, whereas coastal cutthroat trout migrate to estuaries and nearshore areas for a matter of months before returning to freshwater. Unlike salmon, steelhead and coastal cutthroat trout may survive after spawning and return to saltwater to forage and make multiple spawning runs. In addition, coastal cutthroat trout exhibiting resident, fluvial (i.e., migrating to larger rivers only) and anadromous life histories are thought to occur in some streams.

The Columbia River basin historically produced some of the world's largest runs of Pacific salmon. Predevelopment estimates of historical abundance for adult salmon of all species returning to the basin range from 7.5 million to 16 million fish annually (NRC 1996). Overfishing and habitat degradation reduced abundance of naturally produced salmon to about one-eighth of their predevelopment abundance by 1900. Habitat loss and degradation, dam operations, and some hatchery practices further reduced abundance of naturally produced, wild salmon. Minimum in-river run estimates for adult Chinook and coho salmon are currently about one million fish (1991-2005 mean 1.09 million, range 0.41-2.26 million; (PFMC 2007). With over 80 million hatchery produced salmon and steelhead annually released in the Columbia River basin (1979-2005 mean 82.16 million, range 66.34-95.09 million for Chinook, coho, and sockeye salmon and steelhead combined (FPC 2006); the majority of adults returning to the basin are artificially produced for most salmon and steelhead stocks (NRC 1996). The status of and threats to anadromous salmonids in the Columbia River basin have resulted in listing 13 evolutionary significant units (ESUs) and distinct population segments (DPSs) of salmon and steelhead as threatened or endangered under the Endangered Species Act (ESA).

Although the presence of salmonids in the Columbia River estuary has seasonal patterns (e.g., peak juvenile abundance in spring and early summer), adults and juveniles consisting of various species, runs, and life-history strategies may be present throughout the year. No salmonid spawning habitat occurs within the boundaries of the refuges. However, opportunities exist to provide access for fish though Julia Butler Hansen Refuge to potential spawning habitat in Risk Creek and alternate access to spawning habitat presently used by coho salmon, steelhead, and

coastal cutthroat trout in Nelson Creek (Johnson et al. 2009, and Yoshinaka and Lohr 2009). Therefore, habitats used directly by salmonids at the two refuges primarily consist of tidally influenced sloughs, marshes, and floodplains for juvenile rearing. These habitats also indirectly provide benefits to salmonids through production and export of nutrients, organic matter, and invertebrates, which contribute to the food web in the estuary.

4.4.1.2 Sturgeon

For anadromous nonsalmonid fish, the largest population of white sturgeon *(Acipenser transmontanus)* in Washington occurs in the Columbia River estuary downstream of Bonneville Dam (Wydoski and Whitney 2003). The abundance of fish 21.3 inches or greater was estimated at 895,500 individuals (range 678,000 to 1,058,300) during 1986 through 1990. White sturgeon feed primarily on bottom organisms such as mollusks, crustaceans, and fish, and can live more than 100 years. A commercial and popular sport fishery exists for white sturgeon. Other anadromous fish in the Columbia River estuary include Pacific lamprey *(Lampetra tridentate)*, green sturgeon *(Acipenser medirostris)*, American shad *(Alosa sapidissima)*, and eulachon (*Thaleichthys pacificus*).

4.4.1.3 Warm Water Fish

Nonnative warm water fish species are found in sloughs within the dikes at Julia Butler Hansen Refuge. These include such species as common carp *(Cyprinus carpio*), brown bullhead *(Ameiurus nebulosus*), pumpkinseed *(Lepomis gibbosus*), bluegill *(Lepomis macrochirus*), largemouth bass *(Micropterus salmoides*), and white crappie *(Pomoxis annularis*) (Johnson et al. 2009). These species were introduced to the Pacific Northwest from other regions to provide a sport fishery and have become established. Most of these species are predators, and likely prey on native fish, amphibians, and aquatic invertebrates. Densities of these introduced species are relatively low outside of diked sloughs at the refuge.

4.4.2 Birds

More than 175 species of birds occur along the lower Columbia River and estuary (LCREP 1999). The habitat mosaic of sand islands, sandbars, tidal mud flats, marshes, swamps, scrub-shrub, and riparian forest attracts an abundance of neotropical migrant song birds, as well as waterfowl, marsh and water birds, and raptors.

4.4.2.1 Water Birds

The refuges provide important wetland habitat that sustains the migratory birds of the Pacific Coast. The refuges are both a wintering area and a migrational stopping area for waterfowl that nest in Alaska and winter in Oregon, Washington, and California. Up to 50,000 ducks are often present during November through April. The most common species are mallard, American wigeon, pintail, green-winged teal, bufflehead, northern shoveler, and greater scaup. In addition, a few thousand resident mallards, cinnamon teal, gadwalls, and wood ducks nest on the refuges during the spring and summer. The tidal and nontidal marshes attract the greatest numbers of

ducks, although shallow open water is preferred by scaup, mergansers, western grebes, common loons, scoters, and ruddy ducks.

Six subspecies of wintering Canada geese *(Branta canadensis)* are found at the estuary—lesser (*B. c. parvipes*), Taverner (*B. c. taverneri*), dusky (*B. c. occidentalis*), western (*B. c. moffitti*), Vancouver (*B. c. fulva*), and Aleutian (*B. c. leucopareia)*. Cackling geese are the most numerous of the wintering geese. Geese forage in the fields on Julia Butler Hansen Refuge's Mainland and Tenasillahe units. They also roost, loaf, and forage in the Estuary Islands Unit of the Lewis and Clark Refuge. There are a total of 10,000 to 15,000 Canada and cackling geese present on the estuary during the winter months. A flock of 300-500 lesser snow geese typically winter in the lower reaches of the Lewis and Clark Refuge. A resident population of approximately 2,000 western Canada geese, nest throughout the estuary. The dredge spoil islands (Miller Sands, Pillar Rock, Fitzpatrick) within the Lewis and Clark Refuge are especially important goose nesting areas.

Approximately 500 to 1,000 tundra swans winter at the estuary, especially in the Lewis and Clark Refuge. Their preferred habitat is tidal marsh, where they feed on the roots and tubers of wapato and other marsh plants.

American bitterns and great blue herons are abundant. There are heron nesting rookeries at both refuges. These colonies are not surveyed regularly, but it is apparent that the number of nesting herons has declined in recent years. This may be due in part to the increase in nesting bald eagles, which prey on heron chicks and eggs. Other factors such as human disturbance and contamination may also be involved. Bitterns nest in fields at the Julia Butler Hansen Refuge. Great egrets are common during winter. The refuges provide wintering habitat for western and pied-billed grebes, and common loons. Red-throated loons visit during spring migration. Virginia and sora rails nest in the marshes and grasslands.

Eight thousand pairs of Caspian terns formerly nested on Rice Island, along with a few hundred pairs of double-crested cormorants. Because the terns were consuming large numbers of juvenile salmon, the colony was moved downriver to East Sand Island in Baker Bay (USFWS 2005b). The cormorants also moved to East Sand Island and joined a larger nesting colony there. A few pairs of cormorants still nest within the Lewis and Clark Refuge on navigation markers. Several hundred pairs of glaucous-winged/western hybrid gulls presently nest at Rice Island and Miller Sands Spit.

4.4.2.2 Shorebirds

Migrating shorebirds feed and rest on intertidal mud flats during the spring, summer and fall. They feed on a variety of invertebrate organisms, including annelid and nematode worms and amphipods. The estuary has been recognized by the Western Hemisphere Shorebird Reserve Network as an internationally important area because more than 100,000 shorebirds are sometimes present. Principal species are dunlin, western sandpiper, short-billed dowitcher, and greater yellowlegs.

4.4.2.3 Raptors

Raptors include bald eagle, peregrine falcon, white-tailed kite, northern harrier, kestrel, merlin, red-tailed hawk, red-shouldered hawk, rough-legged hawk, Cooper's hawk, sharp-shinned hawk, and osprey; and barn, great horned, short-eared, barred, screech, saw-whet, and pygmy owls.

4.4.2.3.1 Bald Eagle

The bald eagle was removed from the federal threatened and endangered species list in 2007. It is still listed as threatened by the states of Oregon and Washington. The species will continue to be closely monitored by Federal and state agencies. Bald eagles are a common resident of the refuges. In 2005, there were 6 nesting pairs on the Julia Butler Hansen Refuge that produced a total of 8 young, and 8 nesting pairs on the Lewis and Clark Refuge that produced a total of 5 young. Eagles on the refuges nest in large cottonwood and Sitka spruce trees. In addition, 27 pairs nested on mainland areas adjacent to the refuges (Isaacs and Anthony 2005).

Environmental contaminants may be reducing the nesting success of bald eagles along the lower Columbia River. Buck et al. (2005) found thin eggshells and elevated levels of DDE, PCBs, and dioxins in eggs taken from nests. Eagle productivity, however, appears to be increasing. The number of young produced per occupied site in the Columbia River Recovery Zone for the period 2001-2005 was 0.994, compared to 0.814 for the preceding five years (1996-2000) (Isaacs and Anthony 2005). The productivity goal in the Pacific Bald Eagle Recovery Plan is a minimum of 1.00 young per occupied site (USFWS 1986).

Eagle numbers in the estuary peak in late winter/early spring, when more than 150 may be present. They perch along the water and forage over shallows and tidal flats at low tide and at first light. They feed primarily on fish, although waterfowl, seabirds, carrion, and small mammals are also taken. Favored fish species are largescale sucker, American shad, common carp, and salmonids (Watson et al. 1991).

The shallow waters, abundant fish and waterfowl, large cottonwood and spruce trees, and relatively low human presence that characterize the refuges make ideal bald eagle habitat. Toxic contaminants in the Columbia River will continue to be an issue for years to come, but national and regionwide cleanup efforts are making progress. The habitat within the refuges is expected to remain suitable. Eagles are susceptible, however, to human-caused disturbance. The presence of people can disrupt an eagle's feeding, resting, and nesting activities. While some eagle populations are fairly tolerant of human presence, other populations are not. Eagles of the Columbia River estuary avoid boats, especially stationary boats, within a distance of about 1,300 to 2,600 feet (McGarigal et al. 1991). The presence of large numbers of recreational boats has the potential to seriously disrupt eagle foraging. Recreational use of the estuary, including the refuges, is increasing and may in the future have negative impacts on eagles.

4.4.2.4 Landbirds

Virtually all landbirds that occur in the region use the refuges for nesting and foraging. Particularly abundant species include song sparrow, savannah sparrow, red-winged blackbird,

tree swallow, common yellowthroat, American robin, yellow warbler, golden-crowned kinglet, marsh wren, Steller's jay, and black-capped chickadee. Less common species found at the refuges include red-eyed vireo and streaked horned lark.

4.4.3 Mammals

The CWT deer is the principal focal species at the Julia Butler Hansen Refuge and may be found in small numbers on the Lewis and Clark Refuge. See the section on threatened and endangered species for information on CWT deer numbers and ecology.

4.4.3.1 Coyote

The coyote is one of the most widely distributed carnivores in North America. Despite more than 100 years of intensive efforts to control coyotes and reduce coyote depredation on livestock, coyotes are abundant and have expanded their range (Litvaitis and Mautz 1980). Human activities have often unintentionally benefited coyotes. For example, coyotes thrived in the Cascades, but only after their habitat was altered by clear cutting, and wolves—which were their primary competitors, were extirpated (Toweill and Anthony 1988).

The coyote's social organization revolves around the mated pair. Each pair occupies a home range that it defends against other coyotes. However, pairs often accept the presence of one or more "associates." These are nonbreeding adults that share the home range and assist in pup rearing duties (Ryden 1989, Andelt 1985). Home range size and coyote density varies according to prey abundance, topography, and vegetative characteristics (Gese et al. 1988). Home ranges often occupy 10 to more than 40 square miles or more (Andelt and Gipson 1979, Litvaitis and Shaw 1980, Springer 1982, Gese et al. 1988), but it may be considerably smaller when conditions are favorable. Gese et al. (1988) and Windberg and Knowlton (1988) reported home ranges as small as 1 square mile. Densities may be higher than home range size would indicate (Hein and Andelt 1995). Ranges of adjacent pairs may overlap, at least at the peripheries (Litvaitis and Shaw 1980), and transient (unmated) individuals whose home ranges overlap those of mated pairs are usually present (Andelt 1985, Gese et al. 1989).

Densities and home ranges on the refuge are unknown, but coyotes are observably common throughout the year. Townsend voles (*Microtus townsendi*) and other small mammals thrive in the fields and provide an abundant, year-round, prey base. The Mainland and Tenasillahe Island units are each about 3 square miles in size. The frequency with which coyotes are observed and heard by refuge staff suggests that 2 or 3 mated pairs are typically occupying each refuge unit.

In accordance with Julia Butler Hansen Refuge's PMP/EA (USFWS 1997), periodic coyote control has been conducted in recent years on some units of Julia Butler Hansen Refuge during the late winter and early spring (late December to April 15). The objective of control efforts was to remove all coyotes from the refuge during the early CWT deer fawning season, but that objective was not always achieved. The number of coyotes removed from the Mainland Unit was 12 in 1997, 1 in 1998, 4 in 2005, 11 in 2006, and 8 in 2007. At Tenasillahe Island, the number removed was 12 in 2004, 6 in 2005, 4 in 2006, and 5 in 2007. The lethal coyote control used on the refuge likely had little effect upon the local population.

Coyote mating on the Julia Butler Hansen Refuge typically occurs during January or February and 5-10 pups for each breeding pair typically are born during April or May (Burt and Grossenheider 1964). Pups are fed by the adults for several months, then disperse from their parent's home range before reaching 1 year of age, but they may remain longer (Nellis and Kieth 1976, Bowen 1982, Andelt 1985). Mortality of pups often exceeds 50 percent during their first year (Nellis and Kieth 1976, Andelt 1985). If each coyote pair on Julia Butler Hansen Refuge has pups in the spring, there would likely be at least 20 coyotes on the Mainland Unit and a similar number on Tenasillahe Island Unit during the summer months.

The typical adult coyote weighs 25-30 pounds, although there is some geographic variation and occasionally individuals may be larger (Berg and Chesness 1978). Coyotes are opportunistic, omnivorous foragers, where the diet is flexible based upon prey that is available. Diets can include large and small mammals such as mice, rats, rabbits, and hares; deer and other wild ungulates; livestock and domestic pets; and carrion; as well as reptiles; amphibians; fish; insects; fruits; and even farm crops such as corn (Bailey 1936, Gier 1957). Deer, especially fawns, are often a major food item for coyotes (MacCracken 1984, Andelt 1985, Toweill and Anthony 1988). During the breeding season, coyotes seek larger prey (e.g., deer fawns) to feed their young (Till and Knowlton 1983). Harrison and Harrison (1984) found that pups at a site in Maine were fed deer fawns almost exclusively during June and July.

A medium-sized coyote requires about 4,800 mice or 8 adult deer per year to meet its basic resting energy needs (Litvaitis and Mautz 1980), however, coyote predation on deer older than 120 days is low on the Julia Butler Hansen Refuge (A. Clark, unpublished data). This does not include the energy needed for hunting, keeping warm, growth, nursing, etc., which could triple the energy requirements. The coyotes on Julia Butler Hansen Refuge would be capable of consuming hundreds of fawns annually if that were their only food, but meadow voles, are likely a major part of the coyotes diet (Reichel 1991).

4.4.3.2 Other Mammals

Mammals that inhabit the forested and pasture areas of the refuges include bobcat, coyote, Virginia opossum, raccoon, porcupine, striped skunk, snowshoe hare, northern flying squirrel, long-tailed weasel, and a variety of small mammals such as bats, mice, voles, moles, and shrews. Black bear and mountain lion occupy the adjacent hills and pass through the refuges occasionally; however, there are no recorded sightings for these large mammals on Julia Butler Hansen Refuge. Columbian black-tailed deer, the most abundant deer species in western Washington and Oregon, have a minimal presence on the refuges. A few occupy Lewis and Clark Refuge's Lois, Mott, and Karlson Islands; and individual black-tails often pass through the Julia Butler Hansen Refuge.

Roosevelt elk are a management concern on the Julia Butler Hansen Refuge. They compete with CWT deer for browse and cover (USFWS 2004). As many as 110 elk occupied the Mainland Unit in 1983. Since the early 1980s, a combination of trapping, transplanting (USFWS 1997), and more recently controlled public hunting, have reduced herd numbers to 20, the refuge's maximum population objective.

Although population estimates (or densities) are not available, small mammals are relatively common on the refuges. Townsend's voles, Townsend's moles, and deer mice are abundant on the refuges. Bushy-tailed wood rats and Norway rats have also been documented. Shrews are commonly observed, but species have not been identified. Shrews that occur in the general vicinity of the refuges include vagrant, Bendire's, and Trowbridge's (WDFW 1999).

Mammals that inhabit the streams, rivers, swamps, and associated riparian habitats within the refuges include mink, beaver, nutria, muskrat, harbor seal, California sea lion, and river otter. The Steller sea lion, a threatened species, follows salmon runs through the estuary.

No bat surveys have been conducted on the refuges. Species that may be present include little brown myotis, big brown bat, Yuma myotis, long-legged myotis, western long-eared myotis, California myotis, silver-haired bat, Townsend's big-eared bat, and hoary bat (WDFW 1999). Many bat species roost and forage in forested areas and use snags and downed logs as day roosts.

4.4.4 Reptiles and Amphibians

Reptiles and amphibians are most abundant in the nontidal habitats of the refuges. This seeming avoidance of tidal areas may be due to the cold waters of the Columbia River, the abundance of predatory fish, and the large tidal fluctuations in water depth.

Refuge staff have conducted surveys of amphibians breeding in ditches and managed wetlands at the Julia Butler Hansen Refuge. The species identified are Pacific tree frog, red-legged frog, American bullfrog, northwestern salamander, and long-toed salamander. All are present in large numbers. Western red-backed salamanders and ensatinas may also be present (neither are aquatic breeders). Bullfrogs breed in ditches and sloughs, but not the managed seasonal wetlands (these typically are dry by late summer and bullfrog tadpoles require two years to mature). Tree frogs, red-legged frogs, and long-toed salamanders breed in greatest numbers in the managed seasonal wetlands, although they also utilize ditches and vernal pools.

Garter snakes are abundant on the diked portions of the Julia Butler Hansen Refuge. Most are either common or western terrestrial garter snakes, although the northwestern garter snake may also be present. Painted turtles are often seen sunning on logs in the sloughs. Northern alligator lizards have been observed a few times, but are considered rare on the refuges.

4.4.5 Invertebrates

Mosquito sampling was conducted on the Mainland Unit in 2005 and 2006, as part of the Washington Department of Health's statewide West Nile virus surveillance. Nine species were identified, including 7 not previously documented in Wahkiakum County. At least 3 of the species found on the refuge are potential vectors of West Nile virus. However, the virus itself has not been detected in the local area. No surveys of other insects have been conducted.

Native freshwater mussels have been declining in North America to the point that nearly three-quarters of the 297 known species are imperiled (Nedeau et al. *undated*). Little information is available concerning mussels on the refuges. Mussels have been seen, but only collected at one

site on Tenasillahe Island. Oregon floaters have been confirmed to be present, while winged floaters are likely. California floaters may also be present. The California floater is a candidate for listing as a threatened or endangered species in the state of Washington, and the Oregon floater is considered a vulnerable species by the Washington Natural Heritage Program.

The tidal flats and shallows support abundant populations of invertebrates that are an important part of the estuary's food chain. Surveys conducted during the early 1980s found a minimum of 64 species in the river bottom sediments (Holton 1984). The amphipod *Corophium salmonis* is a major food item of juvenile salmon and other small fish (Bottom 1984). Other amphipods including *Cororphium*, along with a wide variety of benthic worms and other invertebrates, are an essential food source for migrating western sandpipers and other shorebirds (Wilson 1994).

4.5 Federally Threatened and Endangered Species

4.5.1 Fish

The definition of "species" under the ESA includes any distinct population segment of vertebrate fish or wildlife. In implementing the ESA, NOAA's Fisheries Service identified Evolutionarily Significant Units (ESU) for Pacific salmon and Distinct Population Segments (DPS) for steelhead, and considers both as species under the ESA. Thirteen species of salmon and steelhead are listed in the Columbia River basin (Table 4-6), 2 of which are endangered and the remaining 11 are threatened. Even though spawning habitat for the salmon and steelhead occurs throughout various watersheds in the basin, all 13 species use the Columbia River estuary as a migratory corridor, and to varying degrees, rearing habitat. The Columbia River estuary has been designated critical habitat as a rearing/migration corridor for 12 of these species, with critical habitat currently being identified for coho salmon. Because the lateral extent of designated critical habitat in estuaries is "extreme high water," much of both refuges are included. The Service has supported habitat restoration actions with partners to improve rearing habitat for juvenile salmonids at the Crims Island Unit and is presently conducting work on sloughs and wetlands at the Tenasillahe Island and Mainland units.

Table 4-6 Federally listed Pacific Salmon and Steelhead in the Columbia River Basin.

Species	Species (ESU or DPS)	Listing status
Sockeye salmon	Snake river	Endangered
	Upper Columbia River Spring-run	Endangered
	Snake River Spring/Summer-run	Threatened
Chinook salmon	Snake River Fall-run	Threatened
	Lower Columbia River	Threatened
	Upper Willamette River	Threatened
Coho salmon	Lower Columbia River	Threatened
Chum salmon	Columbia River	Threatened
	Upper Columbia River	Threatened
	Snake River Basin	Threatened
Steelhead	Lower Columbia River	Threatened
	Upper Willamette River	Threatened
	Middle Columbia River	Threatened

Bull trout (*Salvelinus confluentus*) is a salmonid federally listed as threatened. It is native to the Pacific Northwest, including the Columbia River basin, and is closely related to the Dolly Varden (*S. malma*). Bull trout are especially dependent on cold, clean streams and rivers for spawning, and may exist as resident or migratory individuals (i.e., reside solely in the stream in which they were spawned versus fish that migrate from spawning streams to larger rivers, lakes, or the ocean). The closest known spawning habitat to the Columbia River estuary is in the upper Lewis River Basin, which is part of the lower Columbia River recovery unit for bull trout (USFWS 2002). Although the estuary was not designated as critical habitat for bull trout, the role of the lower Columbia River in bull trout recovery has been identified as a primary research need in the draft Bull Trout Recovery Plan.

4.5.2 Birds

4.5.2.1 Brown Pelican

Endangered brown pelicans are common during spring, summer, and fall in the lower estuary. Most are immature and nonbreeding adult birds. The number of pelicans in the estuary has soared since the 1980s. East Sand Island in Baker Bay is a primary night roost. Approximately 11,000 pelicans were counted there in 2002 (Wright et al. 2003). Pelicans utilize the brackish water from Tongue Point downstream in the estuary and the offshore waters, and only occasionally venture into the downstream portion of the Lewis and Clark Refuge.

Brown pelicans feed on fish, especially herrings and anchovies. They typically feed by plunging into the water when fish are spotted, although they also catch fish by swimming into surfacing schools of baitfish (Shields 2002). There is an abundance of anchovies and other schooling marine forage fishes near East Sand Island (Emmett et al. 2003). These fish species likely comprise the majority of the diet of brown pelicans that roost on East Sand Island (Roby 2007).

4.5.2.2 Northern Spotted Owl and Marbled Murrelet

Threatened northern spotted owls and marbled murrelets occur in western Washington and Oregon, but they are not known to utilize the refuges.

4.5.2.3 Streaked Horned Lark

The coastal strain of the streaked horned lark is a candidate for protection under the ESA. In the Columbia River estuary, streaked horned larks are found in sparsely vegetated sandy areas that are dominated by grasses and forbs with few or no trees or shrubs (Pearson and Hopey 2005). This type of habitat occurs mainly on the dredge spoil islands. Islands within the approved boundaries of Lewis and Clark and Julia Butler Hansen Refuges that support breeding pairs of horned larks are Rice, Miller Sands Spit, Pillar Rock, and Crims. Streaked horned larks have also been seen on Welch, Tenasillahe, and Wallace Islands but have not been confirmed as breeding there. As the vegetation develops on the dredge spoils, these areas will likely support breeding birds as well. While the dredge spoil areas are not presently part of the refuge, one or more of them may become so if an agreement is reached with the ODSL. Currently, streaked horned larks are not known to occur on either refuge.

4.5.3 Mammals

4.5.3.1 Stellar Sea Lion

An estimated 25,000 Steller sea lions (threatened), also known as northern sea lions, frequent the Washington and Oregon coasts. As many as 1,000 Steller sea lions use the south jetty at the mouth of the Columbia River as a haul out site (NOAA 2006). Some of these animals follow runs of smelt (eulachon) and/or salmon up the river, through waters that are within or adjacent to the refuges. Steller sea lions have been observed upstream in the Columbia River as far as Bonneville Dam. It is likely that some individuals occasionally haul out on sand bars within the Lewis and Clark Refuge. There is increasing controversy over sea lions and harbor seals eating salmon in the river. Harassment and even lethal take are being discussed as means of reducing marine mammal predation on threatened and endangered salmon runs. Much remains to be learned about the interactions between marine mammals and salmon in the estuary.

4.5.3.2 Columbian White-tailed Deer

4.5.3.2.1 Distribution

The endangered CWT deer likely was abundant within its historic range, which likely encompassed floodplain and riverside habitats in the lowlands from southwestern Oregon (Roseburg) to the south end of Puget Sound (Bailey 1936, Smith 1985). In 1806, Lewis and Clark observed and harvested white-tailed deer along the Columbia River from approximately The Dalles, Oregon, to Astoria, Oregon (Thwaites 1905). By the early 1900s, the CWT deer had been extirpated throughout much of its historic range (Jewett 1914, Bailey 1936) as a result of habitat loss and degradation primarily from agriculture conversions and logging as well as industrial and urban development (Brookshier 2004, Gavin et al. 1984). Scheffer (1940) documented the presence of CWT deer along the lower Columbia River in 1939, where an estimated 500 to 700 animals inhabited diked floodplain areas near Cathlamet, Washington, and Westport, Oregon. Small numbers of white-tails (presumably CWT deer) were also known to exist along the Umpqua River in the vicinity of Roseburg, Oregon, in Douglas County.

4.5.3.2.2 Recovery Criteria

The CWT deer was federally listed under the Endangered Species Preservation Act (P.L. 89-669, 80 Stat. 926) during 1968 when only a small population (300-400 deer) was known to exist along the lower Columbia River as one minor and four main subpopulations in southwest Washington and northwest Oregon (USFWS 1983). During 1978, a population of approximately 2,000-2,500 CWT deer was found in Douglas County, Oregon, that was then federally listed as endangered.

The recovery plan for CWT deer addressing both geographically isolated, distinct populations was released during the early 1980s (USFWS 1983). In southwest Oregon, land use planning and zoning ordinances were implemented along with other conservation actions specified in the recovery plan. As a result, this population has increased to approximately 6,000 deer with subsequent delisting during summer 2003. In the lower Columbia River area, conservation activities from the recovery plan focused on securing and managing lowland habitats, including

establishment of the Julia Butler Hansen Refuge. To down list the lower Columbia River population to threatened, the recovery plan specified a population of more than 400 CWT deer must be maintained in 3 or more viable subpopulations of 50 deer or more, with 2 of the subpopulations located in secure habitat. Three or more viable subpopulations located in suitable and secure habitat, would be required to federally delist the CWT deer. As described in the recovery plan, secure habitat is free from adverse human activities such as clearing woody plants and unregulated heavy grazing by domestic animals. The Mainland and Tenasillahe Island units provide secure habitat for 2 of the 4 subpopulations of CWT deer in the lower Columbia River. Presently, there are 4 established, viable subpopulations along the Columbia River in Washington and Oregon on the Mainland Unit, Tenasillahe Island Unit, Puget Island, and Westport/Wallace Island.

All of the subpopulations in the lower Columbia River are viable (more than 50 deer), where the total population was more than 500 deer during 2009 (Table 4-7). However, only 2 of the established subpopulations (Mainland and Tenasillahe Island units) are in secure habitat. Therefore, the recovery criteria can be met only by securing habitat for a third subpopulation or establishing a new subpopulation in secure habitat. The Service attempted to secure approximately 1,700 acres of habitat for the Westport/Wallace Island subpopulation, but only 800 acres have been acquired to date (including 579-acre Wallace Island). This area is insufficient to support a viable subpopulation of more than 50 deer. Subsequently, efforts have focused on establishing a new subpopulation on public lands.

Table 4-7 Estimated number of CWT deer in the lower Columbia River population, by subpopulation, in 2009.

Subpopulation	Number of Deer
Mainland Unit	61[1]
Tenasillahe Island Unit	112[1]
Puget Island	156
Westport/Wallace Island	161
Upper Estuary Islands	97
Population Total	587

[1]Numbers reflect the effects of a severe flood on the Mainland Unit in 2009 and the subsequent translocation of 20 deer from Tenasillahe Island to the Mainland Unit.

Beginning in 1999, the Service, WDFW, and ODFW transplanted CWT deer to a group of undeveloped river islands (collectively referred to as the Upper Estuary Islands) located immediately upstream of the existing population. The combined land area of these islands is about 1,730 acres; most is publicly owned (Table 4-8). From 1999 to 2006, 191 CWT deer were translocated to the Upper Estuary Islands from Puget Island, Westport, and the Mainland Unit.

Table 4-8 Upper Estuary Islands Acreage and Land Ownership

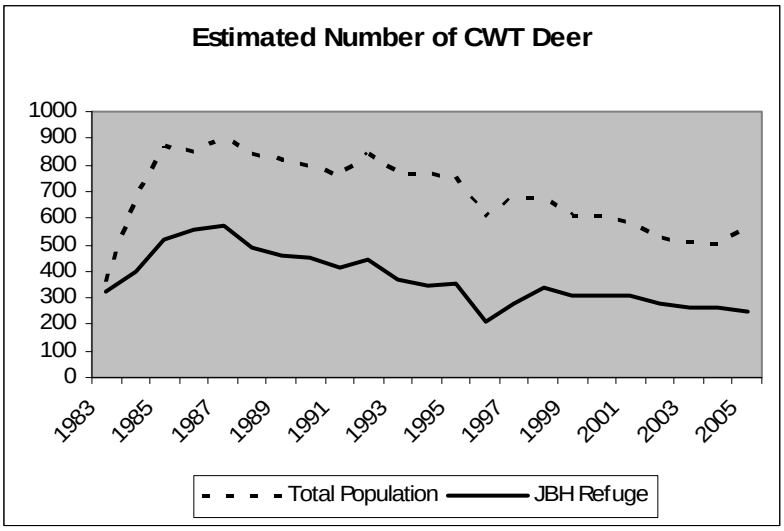
Island	Approx.Acres	Land Ownership
Crims	720	Julia Butler Hansen Refuge 473 acres; privately owned land 130 acres; ODSL 117 acres
Fisher	255	Washington Department of Fish and Wildlife
Hump	150	Washington Department of Natural Resources
Lord	500	Oregon Department of State Lands
Walker	109	Private, Columbia Land Trust has a 50-year conservation lease

4.5.3.2.3 Population Demographics

Population Trends in the Lower Columbia River

The lower Columbia River population has experienced considerable fluctuations with a long-term declining trend (Meyers 2008 and 2009). Based upon ground and aerial classification surveys (fawns, does, and bucks) as well as monitoring reproductive success, the total estimated population has ranged from 900 (1988) to 350 (1983) with the 2009 level at approximately 593 deer. On Julia Butler Hansen Refuge, the CWT deer population has ranged from 575 (1988) to less than 200 (1996) (Figure 4-1), where the lowest estimate occurred after extensive river flooding caused substantial mortality. In February 2009, there were an estimated 235 CWT deer on Julia Butler Hansen Refuge and 358 animals on nonrefuge lands (Meyers 2009). Severe flooding on the Mainland Unit during 2006 and 2009 caused short-term, substantial population declines within this unit. This decline was offset by a recent increase on Tenasillahe Island. However, long-term declines are more substantial. From 1988 to present, the CWT deer in the lower Columbia River population and on Julia Butler Hansen Refuge have exhibited long-term declines of 34 percent and 59 percent respectively.

Figure 4.1 The estimated number of CWT deer in the lower Columbia River population and the estimated number on the Julia Butler Hansen Refuge, by year from ground and aerial classification surveys.



Survival Rates

Using CWT deer classification data from aerial and ground surveys conducted during winter months over the past three decades, a deterministic projection-matrix model with an optimization routine (White 2000*a*, White and Lubow 2002, Phillips and White 2003) was used to estimate average annual survival rates of adult bucks, adult does, and fawns for the Mainland and Tenasillahe Island units.

Note to readers: Symbols used in this section include the following:
$\hat{S}_B$—survival rates of adult bucks older than 18 months;
$\hat{S}_D$—survival rates of adult does older than 18 months; and
$\hat{S}_J$—survival rates of fawns/juveniles 6-18 months old.

Optimized values for model parameters (survival rates) were estimated through iteration. The deterministic model also included other factors (e.g., weather severity index) in order to make it site-specific for CWT deer on Julia Butler Hansen Refuge. A set of explicit assumptions (e.g., juveniles were recruited into the herd during the winter survey of their second year at 1.5 years old) was identified before the modeling was conducted. Deterministic model fit was adequate for the Mainland and Tenasillahe Island units because estimated population size was generally either close to ground counts (adjusted for sighting probability) or between observed and adjusted ground counts. Data from early mark-resight surveys (Mainland Unit only) and from aerial surveys also indicated fitness of the deterministic models.

All CWT deer survival rates were slightly higher for Tenasillahe Island Unit compared with the Mainland Unit's survival rates of: $\hat{S}_J = 0.814$, $\hat{S}_D = 0.839$, and $\hat{S}_B = 0.685$ derived from deterministic modeling. For the Tenasillahe Island Unit, survival estimates from modeling were: $\hat{S}_J = 0.849$, $\hat{S}_D = 0.875$, and $\hat{S}_B = 0.773$.

Population Trends of the Mainland and Tenasillahe Island units

The historical population trends of the Mainland and Tenasillahe Island units for the deterministic models were then evaluated by calculating the annual rate of population change (λ) using the following formula.

$$\lambda = \left\{ \prod_{t=1}^{k} \left[N(t+1) / N(t) \right] \right\}^{1/k}$$

Where *N* is population size, *t* is incremented year, and *k* was total number of years. A λ value equal to 1 implies a stable population trend. Population rates of change indicated a long-term decline in deer numbers for the Mainland Unit (λ = 0.956) and relative stability for Tenasillahe Island Unit (λ = 1.004). The long-term population trend derived through deterministic modeling was consistent with long-term classification survey data (Figure 4.1) from Julia Butler Hansen Refuge.

Deer Densities

Estimated deer densities on Julia Butler Hansen Refuge from herd classification data have varied considerably over time. Gavin et al. (1984) estimated the density on the Mainland Unit ranged from 52-74 deer per square mile (164 to 230 total deer) during 1972-1977. Densities have been as high as 160 deer per square mile during the mid 1980s and as low as 19 deer per square mile following floods during 1996 and 2006. At the Tenasillahe Island Unit, estimated densities have ranged from less than 15 deer to 64 deer per square mile. Both Tenasillahe Island and the

Mainland units are intensively managed to provide habitat for CWT deer, and they support higher densities compared with other natural, unmanaged units of Julia Butler Hansen Refuge with lower average densities of deer. For example, in recent years, estimated densities (based on Forward Looking InfraRed (FLIR) surveys—a method of surveying wildlife populations using a camera-equipped aircraft.) on Wallace and Hunting islands have been about 30 deer and 10 deer per square mile, respectively. In 1940, Scheffer (1940) estimated the total lower Columbia River population was 500-700 deer in an area of about 42.6 square miles (with a density of 12 to 16 deer per square mile).

In other parts of the U.S. with unhunted deer populations, researchers have examined various aspects of white-tailed deer density and carrying capacity. In a long-term study, the carrying capacity of the George Reserve in Michigan was estimated at 98 deer per square mile (McCullough 1984). However, deCalesta and Stout (1997) postulated that at this density biodiversity and forest regeneration would be severely impacted. They recommended using the concept of relative deer density (RDD), where the desired density would be a proportion of the carrying capacity. The exact proportion would depend on management objectives. For example, the RDD for maintaining maximum biodiversity at the George Reserve was less than 20 deer per square mile. The RDD for maximum production of deer (the maximum sustained yield) was about 55 deer per square mile. Densities at the George Reserve reached 122 deer per square mile during some years. In contrast, white-tailed deer densities in an unhunted population on the Huntington Wildlife Forest in upstate New York ranged from about 16 to 31 deer per square mile during a 30-year period (McNulty et al. 1997). There are many other examples in the literature of white-tailed deer densities; however, those previously discussed represent a reasonable range of densities for largely unhunted populations in natural habitats, which is similar to the Julia Butler Hansen Refuge setting.

Population Objectives

The Mainland and Tenasillahe Island units are managed to maintain healthy and sustainable populations of CWT deer at relatively higher densities. Forty deer per square mile is a reasonable density for Tenasillahe Island which is less vulnerable to flooding. Because the Mainland Unit is more susceptible to flooding, a density of 35 deer per square mile is appropriate for this unit. Unmanaged islands (Wallace, Hunting, Price, and Kinnunen Cut) are more likely to support densities of 20 deer per square mile while still maintaining biodiversity. Crims Island (presently a mix of riparian forest, old fields, and tidal swamp) is likely to support 30 deer per square mile until forest replaces the old fields during the next 10 to 20 years. Therefore, the total estimated population on Julia Butler Hansen Refuge would be more than 330 deer (Table 4-9). Other lands in public or conservation ownership (e.g., Fisher Island, Lord Island, Hump Island, White Island, Willow Grove wetlands) would be expected to support CWT deer numbers to significantly contribute toward the recovery goal of 400 deer on secure habitat.

Table 4-9 Population estimates, by refuge unit, for CWT deer on the Julia Butler Hansen Refuge in southwest Washington and northwest Oregon.

Refuge Unit	Area (square miles)	Population Estimate	
		Deer per square mile	Total Deer
Mainland	3.5	35	123
Tenasillahe Island	3.1	40	124
Wallace Island	0.9	20	18
Hunting Island*	1.2	20	24
Price Island*	0.2	20	4
Crims Island*	1.1	30	33
Kinnunen Cut Island	0.1	20	2
Westport Wetlands	0.2	20	4
Total Deer			332

*Not all of the acreage is part of the refuge, but habitats on the nonrefuge lands are expected to remain intact for at least the next 15 years.

4.5.3.2.4 Diet and Nutrition

White-tailed deer are considered browsers consuming leaves and twigs of woody plants. However, they are generalist herbivores readily grazing on available forbs, grass, fruits, nuts and fungi. Physiologically, they could be classified as grazing animals (Nagy et al. 1967).

Based on observations of feeding deer during the period 1972-1976, Suring (1979) and Gavin et al. (1984) reported that CWT deer on the Mainland Unit were primarily grazers, feeding mostly on grasses and forbs. A quantitative food habits analysis, based on micro histological examination of deer feces, conducted on the Mainland Unit in 1978-1979 (Dublin 1980) found that browse was more important than previously thought for this herd. Browse comprised 23 percent of the annual diet. Browse consumption peaked during fall and winter at 30 percent and 35 percent, respectively. The principle browse species was evergreen blackberry (*Rubus laciniatus*). Based upon subsequent knowledge of food habits on the refuge, it is likely that the blackberry was actually a mix of evergreen, Himalayan (*R. discolor)*, and trailing blackberry (*R. ursinus*). Grasses comprised 39 percent and forbs 38 percent of the annual diet of CWT deer. Grass consumption peaked at 51 percent of the CWT deer's diet during spring; whereas, forb consumption peaked at 51 percent during summer.

A more intensive diet and nutrition study, which used microhistological techniques, was conducted by refuge staff during the period 1996-1998. The study area was expanded to include Tenasillahe Island and off-refuge habitat near Westport, Oregon, along with the refuge's Mainland Unit. Ten to 15 fresh fecal samples were collected monthly from each area for two years. Samples were collected throughout each area for representation of deer from the entire area. Monthly samples for each area were combined and analyzed for plant composition, fecal nitrogen (FN), and fecal diaminopimelic acid (DAPA). Fecal nitrogen and DAPA are indicators of diet quality in terms of protein and energy, respectively. During the second year of the study, samples of the principle plants in the diet, as determined from the first year's fecal analysis, were collected by hand seasonally (spring is March, April, and May; summer is June, July, and August; fall is September, October, and November; winter is December, January, and February), dried and ground, mixed in proportion to their occurrence in the diet, and analyzed for

digestibility, protein, fat, and fiber. All analyses were conducted by the Wildlife Habitat and Nutrition Lab at Washington State University.

There were some dietary differences among the three sites (Table 4-10). At the refuge's Mainland Unit, the content of the annual diet was 19 percent browse, 44 percent grasses and sedges, 33 percent forbs, and 4 percent others (lichens, mushrooms, berries, ferns, seeds). In contrast, deer at Tenasillahe Island Unit and Westport consumed more browse and less grass. Annual diet content at Tenasillahe Unit was 36 percent browse, 30 percent grasses and sedges, 28 percent forbs, and 6 percent others. At Westport, the annual diet content was 38 percent browse, 29 percent grasses and sedges, 32 percent forbs, and 1 percent others. Blackberry (*Rubus* spp.) was the major browse consumed at all three areas. Grasses were heavily utilized during winter at all three areas; whereas forbs characterized the diet during spring and summer. Although reed canarygrass was the most abundant and available grass species at all 3 locations, it was underrepresented in the diet. In contrast, the deer consumed grasses from improved pastures including orchardgrass (*Dactylis* spp.), foxtail *(Alopecurus* spp.), bentgrass (*Agrostis* spp.), brome grass (*Bromus* spp.), and timothy (*Phleum* spp.). The most heavily utilized forbs were creeping buttercup (*Ranunculus repens*), horsetail (*Equisetum* spp.), birds-foot trefoil (*Lotus corniculatus*), and cut-leaved geranium (*Geranium dissectum*). These forbs also were abundant in improved pastures.

Table 4-10. Seasonal and annual food consumption, by forage class, expressed as a percentage of the total diet of CWT deer at three locations in southwest Washington and northwest Oregon, 1996-1998.

	FORAGE CLASS (percent)								
	Browse			Grasses			Forbs		
Season[1]	M[2]	T[2]	W[2]	M[2]	T[2]	W[2]	M[2]	T[2]	W[2]
Fall	10.77	48.72	49.28	50.65	36.77	32.77	36.00	12.62	17.10
Winter	17.03	30.32	31.90	69.58	52.78	47.42	6.52	1.83	19.07
Spring	23.78	30.42	26.08	38.10	28.00	24.88	35.57	40.07	46.32
Summer	24.65	36.23	44.98	19.05	4.13	9.72	55.10	58.90	44.27
Annual	19.06	36.42	38.06	44.35	30.42	28.70	33.30	28.35	31.69

[1] The sum of the seasonal percentages for each area is less than 100 percent because of the presence in the diet of small amounts of other items, such as lichens, mushrooms, ferns, and berries.
[2] Location codes are M = Mainland Unit, T = Tenasillahe Island Unit, and W = Westport.

The differences in diets among the 3 areas likely related to differences in forage availability. High quality short grass/clover fields were available on the Mainland Unit as a result of intensive habitat management. In contrast, the Tenasillahe Island Unit had fewer short grass fields that were not well distributed through the island. Because the Westport area was a hybrid cottonwood plantation at the time of the study, grass availability was limited to tree stand edges. Although blackberry, the principle browse plant, was readily available at all 3 areas, CWT deer at the Mainland Unit consumed less browse and more grasses than at Tenasillahe Unit or Westport. It is likely CWT deer on the Mainland Unit selectively foraged on grasses and forbs characteristic of managed, improved pastures compared with naturally available blackberry.

Along with forage availability, it is also important to know the nutritional quality of the deer's forage. Insufficient forage quantity and/or quality can be a limiting factor for ungulate populations. Because of the difficulty of determining the nutritional status of free-ranging wild

animals, fecal indices of dietary quality are often used to assess forage quality. Droppings are collected and analyzed for various compounds. Two widely used indices for deer and elk are fecal nitrogen (FN) and fecal diaminopimelic acid (DAPA) (Osborn and Ginnett 2001, Irwin et al. 1993, Cook et al. 1994, Leslie et al. 1989, Hodgman et al. 1996). Fecal nitrogen indicates the protein content of the diet; whereas, DAPA is an index of dietary energy. High tannin content in the forage can confound forage quality (Osborn and Ginnett 2002, Robbins et al. 1987, Robbins 1983), but the plants consumed by CWT deer are generally not high in tannins.

Fecal nitrogen values for CWT deer at the Mainland Unit, Tenasillahe Island, and Westport indicate considerable seasonal variation (Figure 4.2), which is likely related to seasonal differences in diet. Values were lowest during late summer, fall, and early winter and highest during spring and early summer. Percent FN at Westport tended to be lower than that at the Mainland and Tenasillahe Island units indicating a diet low in protein. However, all of the values are relatively high when compared to reported values for deer in other areas. The mean annual FN for the Mainland and Tenasillahe Island units and Westport was 3.93 percent, 4.17 percent, and 3.54 percent, respectively. The lowest monthly value was 2.49 percent at Tenasillahe Island Unit during January 1997, but values less than 3.00 percent occurred rarely. Examples of FN values from other areas include the following: 2.16 percent for captive deer fed a high protein diet from October through December in Texas (Brown et al. 1995); 2.17 percent and 1.44 percent for pregnant females fed high protein and low protein diets in Texas (Howery and Pfister 1990); 1.99 percent to 2.15 percent for free-ranging white-tails in Oklahoma in February (Jenks et al. 1989); and a low of 1.24 percent and a high of 3.72 percent in March and July, respectively, for free-ranging white-tailed deer in Maine (Leslie et al. 1989). In summary, the FN values for CWT deer indicate a dietary protein content that is more than adequate for growth and reproduction.

Fecal DAPA values followed seasonal trends of FN (Figure 4.3), where values were highest during spring and early summer and steadily declining through late summer and fall. The DAPA values were similar for all three areas. The mean annual fecal DAPA for the refuge Mainland Unit, Tenasillahe Island, and Westport was 1.13 percent, 1.18 percent, and 1.11 percent, respectively. Fecal DAPA reached a low point during fall, and then in winter began to increase and continued to increase until late spring/early summer. This corresponds to the cycle of vegetative growth in this mild climate: Many plants begin growing during February; there is a flush of vegetative growth during spring and early summer; then plants flower and mature during summer, becoming more fibrous and less digestible. Seasonal peaks in fecal DAPA ranged from about 1.3 percent to 1.8 percent. Seasonal lows ranged from about 0.7 percent to 0.9 percent. As with FN, these values are higher, when compared with values from other areas. Values for white-tailed deer in Maine ranged from about 0.5 percent (March) to 1.4 percent (September) (Leslie et al.). Values for captive white-tails fed a high energy diet in Texas averaged about 0.6 percent (Brown et al. 1995).

Figure 4.2 Monthly mean fecal nitrogen values (percent) for three subpopulations of CWT deer in southwest Washington and northwest Oregon, August 1996–July 1998.

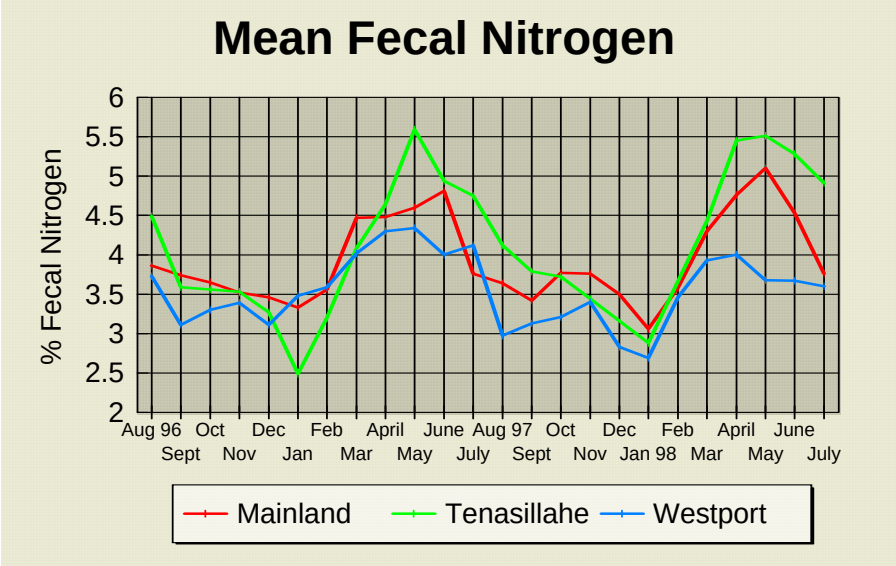
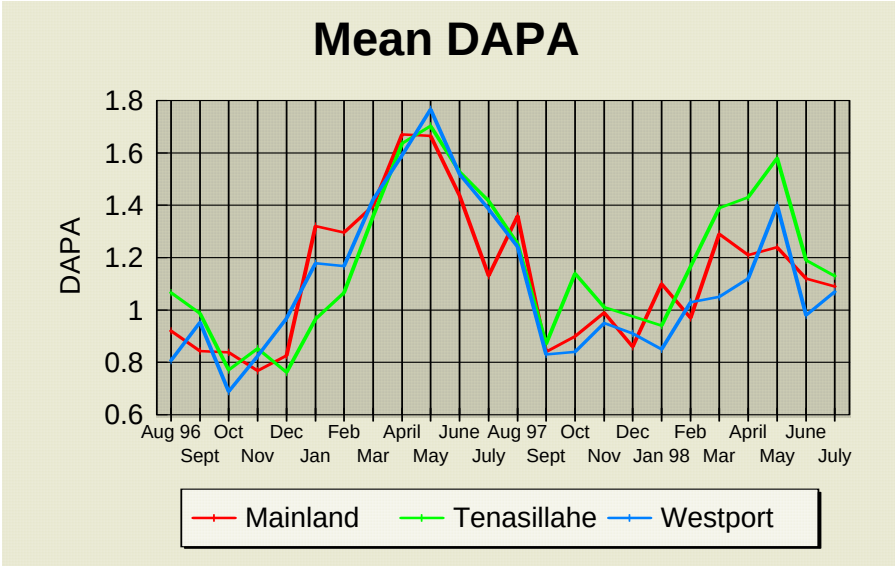


Figure 4.3 Mean monthly fecal DAPA values (mg/g) for 3 subpopulations of CWT deer in southwest Washington and northwest Oregon, August 1996–July 1998.



Analysis of CWT deer seasonal diets (plant samples mixed in proportion to their occurrence in the diet) verified that Julia Butler Hansen Refuge deer are consuming a quality diet with respect to protein and energy (Table 4-11). Crude Protein (CP) values ranged from 15 percent to 22 percent (dry-matter basis). The protein requirement for growth of weaned fawns is 14 percent to 22 percent (Ullrey et al. 1967). Yearlings apparently require about 11 percent (Holter 1979) and adults require as little as 6 percent to 10 percent (French et al. 1955). The availability of protein, energy, and other nutrients in forage is dependent on digestibility. The dry matter digestibility of

the diets of CWT deer ranged from about 59 percent to 71 percent (Table 4-11). All of the seasonal values were more than 60 percent, except for Westport during the fall. Dry matter digestibility greater than 50 percent is considered adequate for deer, assuming the forage has adequate nutrient content (Verme and Ullrey 1984).

Table 4-11 Seasonal crude protein (CP) and in vitro dry matter digestibility (IVDMD) for diets of 3 subpopulations of CWT deer in southwest Washington and northwest Oregon.

	CP (percent)			IVDMD (percent)		
Season	M[1]	T	W	M	T	W
Fall	18.68	17.18	17.22	70.13	64.02	59.46
Winter	20.74	20.22	20.15	69.60	62.33	67.99
Spring	22.37	17.33	17.79	69.84	61.46	71.05
Summer	15.56	15.38	17.25	61.10	63.36	60.09

[1]Locations are M = Mainland Unit, T = Tenasillahe Island Unit, and W = Westport.

The CWT deer's diets were also analyzed for calcium (Ca) and phosphorus (P) content. Both are major constituents of bone and are essential for many other metabolic functions. White-tailed deer require about 0.45 percent Ca and 0.28 percent P in their diet on a dry matter basis (Ullrey et al. 1973, Ullrey et al. 1975), although 0.64 percent Ca is needed for maximum antler growth (Magruder et al. 1957). The diets of the deer at the Mainland Unit, Tenasillahe Island Unit, and Westport contained adequate amounts of Ca and P (Table 4-12). The P content tended to be slightly low in summer and fall at all 3 locations; whereas, the Ca content was generally lowest, but still adequate, in spring. The P content dropped slightly below the requirement of about 0.28 percent in summer at the Mainland Unit, in summer and fall at Tenasillahe, and in fall at Westport. A P deficiency on Julia Butler Hansen Refuge is unlikely because Ca levels were adequate during these seasons and a modest deficiency of P can be tolerated if Ca is adequate (Magruder et al. 1957).

Table 4-12 Seasonal calcium and phosphorus content of the diets of 3 subpopulations of CWT deer in southwest Washington and northwest Oregon.

	Calcium (percent)			Phosphorus (percent)		
Season	M[1]	T	W	M	T	W
Fall	0.79	0.78	0.89	0.30	0.24	0.26
Winter	0.45	0.64	0.70	0.35	0.30	0.31
Spring	0.44	0.51	0.54	0.35	0.32	0.34
Summer	0.77	0.82	0.64	0.26	0.24	0.28

[1] Locations are M = Mainland Unit, T = Tenasillahe Island Unit, and W = Westport.

The CWT deer's diets were also analyzed for selenium (Se). The soils are low in Se (Hansen et al. 1993) and previous research (Creekmore and Glaser 1999) (see also 4.5.3.2.3 Population Objectives) found low serum Se levels in CWT deer on the Mainland and Tenasillahe Island units. A Se deficiency in CWT deer can inhibit reproduction, as well as lead to tissue breakdown (Maynard and Loosli 1969, Robbins 1983, Hansen et al. 1993). The Se requirement for white-tailed deer is not known. The Se requirement for sheep is approximately 0.3 parts per million (ppm) in the forage (Merck 2006). The situation is further complicated by the fact that Se and Vitamin E are interrelated, and a deficiency of one may be ameliorated by a sufficiency of the other (Robbins 1983). The Se content of the monthly deer diets from the Mainland Unit ranged from 0.23-0.86 ppm with a yearly average of 0.43 ppm. At Tenasillahe, monthly values ranged

from 0.01-0.60 ppm with a yearly average of 0.19 ppm. The Se content at Westport was lowest with monthly values ranging from 0.01-0.24 ppm and a yearly average of 0.09 ppm. Allaway and Hodgson (1964) found that Se deficiency symptoms sometimes occurred in sheep and cattle when forages contained less than 0.1 ppm. Brady et al. (1978) found no signs of Se deficiency in white-tailed deer fed a diet containing 0.04 ppm Se. Free-ranging female black-tailed deer in an area of California where the Se content of forage averaged 0.01 ppm produced more fawns when given Se supplementation (Flueck 1994).

The Se content in forages from the Mainland and Tenasillahe Island units is apparently adequate. The lowest monthly values at Tenasillahe Unit are borderline deficient, but it is unlikely that short-term deficiency would cause any symptoms, especially when the Vitamin E interaction is considered. Vitamin E is relatively abundant in green forages, particularly immature green forages (Maynard and Loosli 1969). Green forages are available year-round to deer in this area. The form of the Se in the CWT deer forages is unknown. Some forms are readily available to animals, but others are not. Thus, Se deficiency cannot be ruled out completely. The Se content from Westport forages is quite low and Se deficiency there is more of a possibility. It is unknown why there are differences in Se levels among the 3 areas. The Mainland Unit, Tenasillahe Island Unit, and Westport are physically close together within the Columbia River floodplain and they share similar sedimentary soils.

In summary, analyses of the deer's diet and the nutritional content of the forages on Julia Butler Hansen Refuge over a two-year period, indicates deer are generally well nourished based upon macro nutrients, protein, energy, calcium, and phosphorus. The Se content of the Julia Butler Hansen Refuge diets also seems adequate although dietary levels of deer on private lands at Westport were lower. Deficiencies of other trace elements such as iodine, copper, zinc, and cobalt are possible, but would be difficult to assess because the requirements of deer for these elements are not known. The concentrations of trace elements in forage plants are usually related to concentrations in the soil, thus animals living on those soils for sustained periods are obviously able to cope with any shortages.

4.5.3.2.5 Fecundity and Natality

The CWT deer does give birth to 1 to 4 fawns annually, with an average of 2 fawns annually. The mean number of fetuses per doe (2 years old or older) is 1.8 (Roseberry and Klimstra 1970, Verme and Ullrey 1984, DelGiudice et al. 2007). Although female fawns breed in some populations, Gavin (1979) found fawns on the Mainland Unit did not breed, where does gave birth for the first time at 2 years of age. He also found that 70 percent of 2 year old does and 100 percent of does older than 3 years were pregnant. Thus, the reproductive potential of deer on Julia Butler Hansen Refuge is quite high. If all fawns born on Julia Butler Hansen Refuge survived, the fawn to doe (F:D) ratios in November would be greater than or equal to 150:100. However, the observed F:D ratios during November have been considerably lower than expected based upon reproductive potential of the herd (Table 4-13). The F:D ratio averages during 1986-2006 were 25:100 and 34:100 for the Mainland and Tenasillahe Island units, respectively. Mean recruitment ($\hat{R}$) and its process standard deviation (SD) were estimated using F:D ratio data during years with no coyote control, with methods described in Burnham et al. (1987), White (2000*b*), and Phillips and White (2003).

Mean recruitment was 0.307 (SD was 0.163) and 0.345 (SD was 0.171) for the Mainland and Tenasillahe Island units, respectively.

The F:D ratio averages during 1986 to 2006 for the off-refuge subpopulations at Puget Island and Westport were 44:100 and 35:100, respectively. The F:D ratios on Julia Butler Hansen Refuge ranged from 0:100 on Tenasillahe Island Unit during 2002 and 2003, to 68:100 on the Mainland Unit during 1984. The highest F:D ratio recorded for any Columbia River subpopulation was 70:100 on Puget Island during 2000. Only limited data are available for the newly established Upper Estuary Islands subpopulation because thick vegetation growth precludes complete herd composition counts. Counts conducted at Willow Grove diked lands near Longview, Washington, and the Diblee Point Flats near Rainier, Oregon, found an average F:D ratio of 28:100 during 2004 to 2006. Considering the large difference between observed and potential F:D ratios, all of the subpopulations are subject to considerable losses of fawns during their first summer.

Table 4-13 Fawn:doe ratios for subpopulations along the lower Columbia River during 1986-2006.

Year	Subpopulation				
	Mainland Unit	Tenasillahe Island Unit	Puget Island	Westport	Upper Estuary Islands[1]
1986	43:100	27:100	40:100	40:100	
1987	34:100	43:100	58:100	56:100	
1988	14:100	53:100	53:100	66:100	
1989	29:100	43:100	40:100	29:100	
1990	30:100	63:100	55:100	56:100	
1991	21:100	55:100	38:100	30:100	
1992	28:100	67:100	58:100	58:100	
1993	11:100	47:100	48:100	41:100	
1994	1:100	52:100	55:100	57:100	
1995	14:100	53:100	47:100	23:100	
1996	15:100	35:100	27:100	45:100	
1997	61:100	39:100	39:100	16:100	
1998	43:100	12:100	45:100	30:100	
1999	16:100	7:100	52:100	10:100	
2000	34:100	8:100	70:100	23:100	
2001	49:100	18:100	49:100	40:100	
2002	25:100	0:100	40:100	29:100	
2003	21:100	0:100	27:100	24:100	
2004	12:100	32:100	36:100	33:100	42:100
2005	4:100	24:100	22:100	14:100	28:100
2006	24:100	39:100	22:100	18:100	15:100
Average	25:100	34:100	44:100	35:100	28:100

[1]Subpopulation was established during 1999 by translocating deer from other areas.

4.5.3.2.6 Mortality factors

Neonatal (14 days old or younger) CWT deer were captured on Julia Butler Hansen Refuge during late May and early June for 10 years from 1978 to 2000. A total of 137 fawns were fitted with breakaway radio-collars and monitored daily for survival during the first 30 days, then 4 times or more per week thereafter, until the breakaway collars fell off (usually at 180 days or

more). Survival of radio-marked fawns was periodically confirmed with visual observations. Dead fawns were recovered as quickly as possible and then shipped to the National Wildlife Health Center (Madison, Wisconsin) for necropsy. The causes of mortality were determined using necropsy results in combination with evidence collected at mortality sites. The causes of mortality were classified as predation, disease, starvation, exposure, or unknown.

Predation was identified primarily based upon the condition of remains including bite marks, wounds, and copious bleeding (White 1973, Garner et al. 1976, Steigers and Flinders 1980). The identification of predator species followed methods described by O'Gara (1978) as well as Wade and Bourks (1984). Where necropsy revealed no evidence of trauma, disease was diagnosed by presence of bacteria or parasites, and starvation if the stomach was empty and the carcass was emaciated. Exposure was identified when other mortality factors were excluded and death was associated with 1-2 days of precipitation combined with cold temperatures. Fawn mortalities with insufficient pathological information from the necropsy and lack of evidence at the mortality site were classified as unknown.

Of the 137 CWT deer fawns radio-marked during our 10-year study, only 29 (21 percent) survived throughout the fawning period (June to November), and were monitored beyond 180 days (range is 194-1,000 days). There were 94 fawn mortalities (Table 4-14), where all of these deaths occurred by approximately 4 months of age. Predation was the primary cause of fawn mortality, where 68 percent of the deaths were attributed to coyotes. In addition, many of the unknown mortalities were likely caused by coyotes, but there was insufficient evidence to definitively classify them as predation. The average age of fawns killed by coyotes was 40 days. Moreover, about 95 percent of predation mortalities occurred during June, July, and August. In contrast, disease and starvation (combined) caused only 14 percent of the deaths during the fawning season. No fawn deaths were caused by exposure. For animals monitored beyond the fawning season, only 17 percent (5 of 29) died before dropping their radio collars, 2 of these CWT deer were killed by coyotes and 3 (11 percent) died of other causes.

The survival rates (95 percent confidence intervals in parenthesis) at the end of fawning season (more than 150 radio-tracked days) for all mortality factors combined were 0.11 (0.01-0.21), 0.22 (0.12-0.32), and 0.53 (0.35-0.72) for 1996, 1999, and 2000 (recent years without coyote control), 1978-1982 (past years without coyote control), and 1997-1998 (recent years with coyote control), respectively (Figure 4.4). The survival rate (all mortality factors combined) was significantly higher (χ^2=11.06, P=0.0009) for recent years with coyote control (1997-1998) compared to recent years without coyote control (1996, 1999, and 2000). Although slightly greater, there was no significant difference (χ^2=3.26, P=0.0711) between survival rates for recent and past year groupings without coyote control.

Note to readers: Symbols used in this section include the following:
χ^2—all mortality factors combined including coyote predation
P—all predation
≥—greater than or equal to
≤—less than or equal to

Coyote predation was the only mortality-specific factor where the survival rate was significantly higher (χ^2=8.35, P=0.0039) for recent years with coyote control compared to recent years without coyote control. For the other cause-specific mortality factors (starvation, disease, and unknown causes), there were no differences ($\chi^2 \leq 3.48$, $P \geq 0.0622$) between recent years with coyote control compared to recent years without coyote control. The mortality rates from coyote predation were higher compared with rates associated with other causes of death throughout the fawning season (Table 4-14). Mortality rates associated with coyote predation ranged from 0.28 to 0.78, where they were generally lower for years with coyote control. Predation by coyotes was the primary source (most important) of mortality during all study years. After predation, disease and starvation varied in importance as mortality factors depending upon the year grouping.

Table 4-14 Causes of mortality for radio-marked CWT deer fawns at Julia Butler Hansen Refuge, in southwest Washington, 1978-2000.

Year	Number Radio-tracked	Predation	Disease	Starvation	Exposure	Unknown
1978	19	9	4	0	0	4
1979	15	6	1	1	0	2
1980	7	3	0	0	0	4
1981	19	8	1	1	0	2
1982	4	1	0	0	0	0
1996	13	9	1	1	0	1
1997[1]	17	3	0	1	0	1
1998[1]	19	11	1	0	0	1
1999	8	6	0	1	0	1
2000	14	8	0	1	0	0
Total	122[2]	64 (68 percent)[3]	8 (9 percent)	6 (6 percent)	0	16 (17 percent)

[1]Years with coyote control conducted prior to the fawning season on the Mainland Unit.
[2]A total of 137 neonates were radio-marked during all study years, where 29 were known to survive to the end of the fawning season.
[3]Percentage of mortality in parentheses that was calculated based upon the total number of mortalities (n=94).

Survival for neonates has been low since Julia Butler Hansen Refuge was established. The apparent survival rate for radio-marked fawns throughout the Julia Butler Hansen Refuge study (1978-2000) was 21 percent. Similarly, neonatal survival was low on Julia Butler Hansen Refuge from 1972 to 1977 (prior to the study) because fawns only comprised approximately 21-33 percent of late fall (November) population. We found survival rates of 24-52 percent and 15-34 percent during the first 60 and 90 days after capture, respectively, for fawns during years without coyote control. Cook et al. (1971) also found low rates of fawn mortality (28 percent) from birth to 90 days in a non-hunted population of white-tailed deer in Texas. Vreeland et al. (2004) found 43 percent and 28 percent survival rates for white-tailed deer fawns to 63 days after capture in agricultural and forested habitats in Pennsylvania, respectively.

Radio-marked CWT deer fawns were apparently healthy. Only 8 percent and 6 percent of the radio-marked fawns died of disease and starvation, respectively. Similarly, Gavin et al. (1984) found that 4 percent of the CWT deer moralities during 1974-1977 were disease caused, where all deaths were attributable to necrobacillosis. They also found no fawns died from nutritional stress. A health assessment conducted on CWT deer (n=20) from Julia Butler Hansen Refuge

during February 1998 found no indication of infectious diseases (BVD, bovine coronavirus, IBR, bovine enterovirus, and *Pasteurella multocida*) and low parasite loads (Creekmore and Glaser 1999). All deer had serum selenium (Se) values below the reference range and 17 percent had Vitamin E levels that were deficient. However, the overall evaluation found CWT deer on Julia Butler Hansen Refuge were healthy despite the Se-Vitamin E deficiency.

Coyote predation was the most important mortality factor impacting survival of CWT deer fawns on Julia Butler Hansen Refuge, where coyotes caused 68 percent of the radio-marked fawn mortalities. This percentage likely was higher because many unknown deaths (16 of 94 or 17 percent) were probably due to coyote predation but lacked conclusive evidence. In contrast, Gavin et al. (1984) found only 17 percent of the fawn mortalities on Julia Butler Hansen Refuge during 1974-1977 were attributable to coyotes; however, 74 percent (40 of 54) of the fawns died of unknown causes that likely included coyote predation. Although coyotes were the only predator identified for CWT deer fawns on Julia Butler Hansen Refuge, other mammalian predators (bobcat, domestic dogs, and fox) killed neonatal deer in the southwestern Oregon population (Ricca et al. 2002). High losses of white-tailed deer fawns to coyotes also were reported by Cook et al. (1971), Beasom (1974), Garner et al. (1976), and Bartush and Lewis (1981).

Considering that coyote predation was identified as the primary cause of fawn mortality, there is scientific evidence indicating coyote likely are limiting recruitment on Julia Butler Hansen Refuge. The mean F:D ratio during November on the Mainland Unit was 26:100 (ranged from 1:100 to 61:100) from 1986-2000, where the highest ratios occurred during years with coyote control (1997-1998). Potential fawn survival is considerably greater because F:D ratios greater than 60:100 have been recorded on Julia Butler Hansen Refuge (1990 and 1992 on the Tenasillahe Island Unit) since the 1980s (USFWS, unpublished data, Julia Butler Hansen Refuge). The highest F:D ratio recorded for any subpopulation in the lower Columbia River was 70:100. Fawn to doe ratios of 100:100 or more are typical for white-tailed deer (McCullough 1984). Gavin (1979) concluded that fawn mortality was controlling recruitment rate and the subpopulation size on the Mainland Unit.

The CWT deer population on Julia Butler Hansen Refuge is believed to be reasonably healthy at the present time. Diseases causing short-term declines in deer numbers elsewhere in the U.S., such as epizootic hemorrhagic disease (Matschke et al. 1984), have not occurred in western Washington and Oregon. Of the diseases deer are susceptible to, necrobacillosis is the only one known to afflict more than just an occasional animal on Julia Butler Hansen Refuge (Gavin et al. 1984, Gavin 1979). This bacterial disease is difficult to diagnose positively, but one of the more obvious symptoms is foot rot (Rosen 1970). Deer with foot rot limp noticeably from swollen and ulcerous feet. Gavin (1979) examined 155 mortalities on Julia Butler Hansen Refuge from 1974 to 1977, where 32 percent (49) were systematic for necrobacillosis. The disease is often chronic; deer can be infected for years and succumb only during old age. Deer with foot rot are observed fairly regularly on Julia Butler Hansen Refuge (A. Clark, pers. comm.), although they are a relatively small proportion of the population. Most appear to be older animals. Based upon available information, it does not appear that necrobacillosis is limiting the population on Julia Butler Hansen Refuge.

Hair loss syndrome is a recent pathological condition of black-tailed deer in parts of western Washington and Oregon (Bender and Hall 2004, Bildfell et al. 2004). The condition is characterized by the loss of hair from substantial areas of the body. The effects on survival are not clear. Mild hair loss has been observed in a few CWT deer fawns and yearlings, but there has been no documented mortality on Julia Butler Hansen Refuge.

A herd health assessment was conducted on Julia Butler Hansen Refuge during February 1998 (Creekmore and Glaser 1999). Nine deer from the Mainland Unit and 11 deer from Tenasillahe Island Unit were captured by drive-netting. Each deer was visually examined for obvious parasites and lesions and tail fat (tail fat is an indicator of body condition). Blood samples were taken for analysis of complete blood count, plasma protein levels, trace minerals, Vitamin E, serology, serum progesterone, and serum chemistry. The serologic screen included testing for agents of bovine virus diarrhea (BVD), infectious bovine rhinotracheitis (IBR), Johne's disease, parainfluenza (P13), bovine respiratory syncytial virus (BRSV), bluetongue (BT), epizootic hemorrhagic disease virus (EHD) strains 1 and 2, and various other pathogens. Fecal samples were analyzed for diaminopimelic acid (DAPA), fecal nitrogen, crude protein, and parasites. Nasal swabs were tested for disease, including BVD, bovine coronavirus, IBR, bovine enterovirus, and *Pasteurella multocida* culture. No evidence of disease was found.

Three of 11 adult females and 4 of 6 adult males were in poor physical condition based on palpation of tail fat. This result is not surprising given that the assessment was done in February. Deer in northern areas typically lose substantial amounts of body fat during winter, in part because they voluntarily reduce their food intake (Fowler et al. 1967, French et al. 1955). Fecal DAPA and nitrogen values indicated that the diet just prior to capture was of good quality. All 20 deer from this study had serum selenium values below the reference range (for domestic animals) and 2 of 12 deer tested had Vitamin E levels that were deficient. Selenium-Vitamin E deficiency may cause problems such as abortions and reduced fertility. Soils in western Washington and Oregon are selenium deficient. Nevertheless, the deer have existed here for thousands of years. Wild animals may adapt to trace mineral deficiencies and have lower requirements than domestic animals, or they may meet their needs through selective foraging (Verme and Ullrey 1984).

Fifty-one percent of the radio-marked fawns on Julia Butler Hansen Refuge were females. This likely represents the sex ratio at birth because only very young (mostly 1-7 days old) fawns were captured for radio-marking. A sex ratio favoring females may indicate the population is not nutritionally stressed, where fecundity is fairly high. As a result, it is assumed that the population on Julia Butler Hansen Refuge is below carrying capacity. In contrast, a population at or above carrying capacity would be nutritionally stressed, fecundity would be lower, and the sex ratio at birth would favor males (Verme 1965, 1969, 1983, McCullough 1979).

Figure 4.4 Survival rates of radio-marked, neonatal CWT deer during the fawning season (June to November) at Julia Butler Hansen Refuge, southwestern Washington, 1978-2000. CC and NCC represent years with and without coyote control on the Refuge.

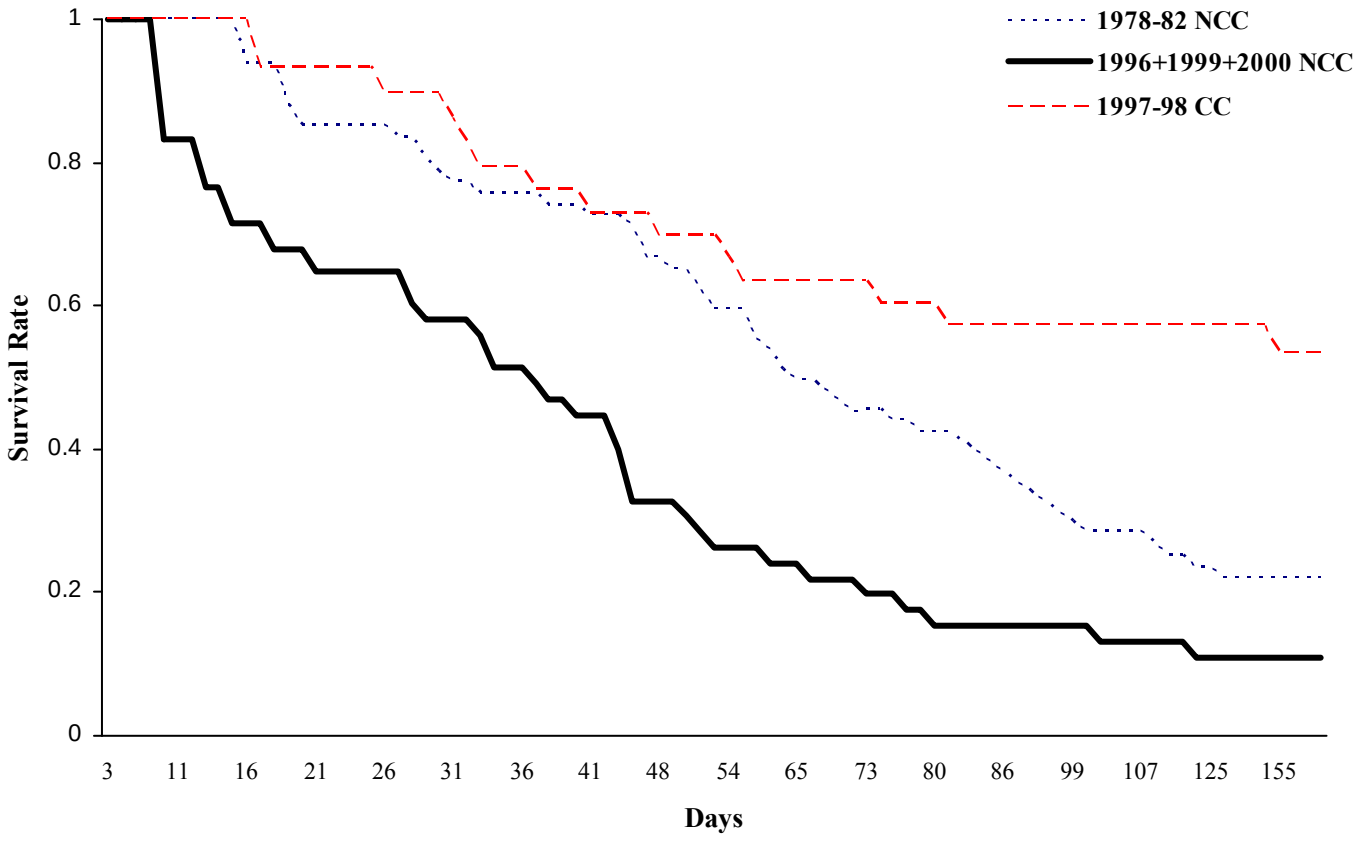


Table 4-15 Cause-specific mortality rates[a] for radio-marked CWT deer fawns at Julia Butler Hansen Refuge, in southwestern Washington, 1978-2000.

	1978-82 NCC[b]			1996+1999+2000 NCC			1997-98 CC[b]		
Cause of Death at	60d	90d	150d	60d	90d	150d	60d	90d	150d
Predation	0.28(48)[c]	0.50(59)	0.55(48)	0.65(66)	0.78(70)	0.81(62)	0.30(73)	0.38(78)	0.42(79)
Disease	0.13(22)	0.13(15)	0.13(11)	0.04(4)	0.04(4)	0.04(1)	0.07(17)	0.07(14)	0.07(14)
Starvation	0.09(16)	0.09(11)	0.09(8)	0.26(26)	0.26(23)	0.26(20)	0.04(10)	0.04(8)	0.04(8)
Exposure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unknown	0.08(14)	0.13(15)	0.38(33)	0.04(4)	0.04(4)	0.20(15)	0.00	0/00	0.00

[a]Mortality rates at 60, 90, and 150 days were calculated using survival rates (*S*) from the Kaplan-Meier estimator modified for staggered entry (Pollock et al. 1989, White and Garrott 1990). Mortality rates were derived as 1-*S*.
[b]NCC and CC represent years with no coyote control and coyote control, respectively.
[c]Relative importance (percent) of a mortality factor for each year-day combination.

Table 4-16 Fawn:doe ratios pre- and post-coyote removal for the Mainland and Tenasillahe Island units in southwest Washington and northwest Oregon. (Ratios are provided for 3 years before coyote control as a basis for comparison)

Year	Mainland Unit			Tenasillahe Island Unit		
	Coyotes Removed	Number Removed	Fawn:doe Ratio	Coyotes Removed	Number Removed	Fawn:doe Ratio
1994	No		1:100			
1995	No		14:100			
1996	No		15:100			
1997	Yes	9	61:100			
1998	Yes	1	43:100			
1999	No		16:100			
2000	No		34:100			
2001	No		49:100	No		18:100
2002	No		25:100	No		0:100
2003	No		21:100	No		0:100
2004	No		12:100	Yes	12	32:100
2005	Yes[1]	4	4:100	Yes	6	24:100
2006	Yes	11	24:100	Yes	4	39:100
2007	Yes	8	3:100[2]	Yes	5	50:100
2008	Yes	13	30:100	Yes	4	39:100

[1]Control actions were ineffective in substantially reducing coyote numbers on the Mainland Unit.
[2]Severe flooding during the previous breeding season may have affected the production of fawns.

4.6 Special Designation Areas

- The Columbia River estuary is part of the National Estuary Program (NEP). The NEP was established by Congress in 1987 in amendments to the Clean Water Act. Its primary objective is to protect estuaries of national significance that are threatened by degradation caused by human activity. The program is administered by EPA which provides funding and technical support to local NEPs, including the LCREP.

- The estuary has been recognized by the Western Hemisphere Shorebird Reserve Network as an internationally important area because more than 100,000 shorebirds are sometimes present.

- The Columbia River was designated as one of the nation's great water bodies by the EPA.

4.7 Effects to Species and Habitats

4.7.1 Effects Common to All Alternatives (IPM)

Potential effects to the biological and physical environment associated with the proposed site-, time-, and target-specific use of pesticides (Pesticide Use Proposals [PUPs]) on the refuges would be evaluated using scientific information and analyses documented in Chemical Profiles (see Appendix D). These profiles provide quantitative assessment/screening tools and threshold values to evaluate potential effects to species groups (birds, mammals, and fish) and

environmental quality (water, soil, and air). The PUPs (including appropriate Best Management Practices [BMPs]) would be approved where the Chemical Profiles provide scientific evidence that potential impacts to refuge biological resources and its physical environment are likely to be only minor, temporary, or localized in nature. Along with the selective use of pesticides, PUPs would also describe other appropriate IPM strategies (biological, physical, mechanical, and cultural methods) to eradicate, control, or contain pest species in order to achieve resource management objectives.

The effects of using nonpesticide IPM strategies (e.g., mowing) to address pest species on the refuges would be similar to those effects described elsewhere within this chapter, where they are discussed specifically as habitat management techniques to achieve resource management objectives on the refuges. For example, the effects of mowing to control invasive plants in an improved pasture would be similar to those effects summarized for mowing, where it would be specifically used to provide short-grass foraging habitat for wintering geese.

Based on scientific information and analyses documented in Chemical Profiles (see Appendix D), pesticides allowed for use on the refuges would be of relatively low risk to nontarget organisms as a result of low toxicity or short persistence in the environment. Thus, potential impacts to refuge resources and neighboring natural resources from pesticide applications would be expected to be minor, temporary, or localized in nature.

4.7.2 Julia Butler Hansen Refuge

4.7.2.1 Effects to Fish

All three alternatives include installing new tidegates at some sloughs that are presently isolated from the Columbia River, and modifying existing tidegates at others to improve connectivity between the sloughs enclosed by dikes (on Tenasillahe Island and Mainland units) and the Columbia River. The new tidegates will enhance water exchange, thereby, improving water quality (e.g., dissolved oxygen) in the sloughs and their connecting drainage ditches. Approximately 180 acres of native trees and shrubs would be planted to establish riparian forest along the sloughs. The trees would eventually provide shade and detritus for the sloughs. Improved water quality and access are expected to benefit fish in the sloughs, especially native species such as juvenile salmon, threespine stickleback, and peamouth. Nonnative invasive species, such as carp, may find the slough habitat less favorable because of lower water temperatures resulting from increased water exchange with the Columbia River. Fish in the estuary would also benefit because the improved connectivity would result in increased export of plant detritus from the Mainland Unit and Tenasillahe Island. Detritus forms the base of the estuary food web.

Alternative 1 proposes no changes in Julia Butler Hansen Refuge's habitat management, public use, and CWT deer management programs. This alternative would be neither more positive nor more negative than the existing situation; including tidegate activities common to all alternatives thus its effects on fish would be neutral.

Alternative 2 proposes establishing an additional 110 acres of short-grass fields, 100 acres of riparian forest, and 40 acres of nontidal wetlands. The additional riparian forest would improve water quality in the sloughs and drainage ditches by providing shade and detritus, thus benefiting juvenile salmon and other native fish. The additional nontidal wetlands would provide habitat for native fish, such as threespine sticklebacks that thrive in shallow water. The habitat enhancements we propose in Alternative 2 would benefit native fish, but these benefits would not be substantially different than those expected for Alternative 1.

Alternative 2 also proposes changes to the public use and CWT deer population management programs. The shorelines of Crims and Price Islands would be opened to hunting for waterfowl and snipe. The predator control program would be expanded, and establishing an experimental population of CWT deer would be emphasized. These activities occur mostly on land and would have no effect on fish or fish habitat. Opening Crims and Price Islands to waterfowl hunting could result in a slight increase in motorized boat use and the resultant water pollution in those areas. However, there would not likely be an increase in the number of hunters using the area; rather, the distribution of hunters may change somewhat. The effects, if any, on fish would be temporary and localized in nature.

Alternative 3 is similar to Alternative 1, it proposes no changes in the refuge habitat management program, and there would be no effects fish. The area open to waterfowl hunting would be increased under Alternative 3, similar to Alternative 2. Opening Crims and Price islands to waterfowl hunting could result in a slight increase in motorized boat use and the resultant water pollution in those areas. However, there would not likely be an increase in the number of hunters using the area; rather, the distribution of hunters may change. The effects, if any, on fish would be neutral. The predator control program would be expanded under Alternative 3; however, predator control occurs on land and would have a neutral effect on fish.

4.7.2.2 Effects to Birds

4.7.2.2.1 Water Birds

Alternative 1 would result in no change in current refuge management programs. The existing habitats and habitat management practices would be maintained. No additional nontidal wetlands, short-grass fields or forests would be restored. The refuge would continue to manage 680 acres of short grass fields that provide food for wintering geese and American wigeon. The existing 130 acres of nontidal wetlands would be managed to benefit wintering ducks, geese and other water birds. No additional wetlands would be restored. The existing forested (riparian and swamp) areas that provide nest sites for wood ducks, hooded and common mergansers, and great blue herons would be maintained. An additional 180 acres of grassland would be converted to riparian forest. Management would emphasize maintaining all habitats in their existing state and continuing existing management practices relating to water birds. Waterfowl hunting (ducks, geese, coots and snipe only) would continue at present levels. Thus, under Alternative 1 there would be a neutral effect to water birds.

Alternative 2, which emphasizes enhanced habitat management, CWT deer population management, and wildlife-dependent public use, proposes establishing an additional 110 acres of

short-grass fields, 100 acres of riparian forest, and 40 acres of nontidal wetlands. This alternative would also open the shorelines of Price and Crims Islands to waterfowl hunting during state open seasons.

Short grass fields would increase from 680 acres to 790 acres under Alternative 2. The added acreage would provide additional foraging area for Canada geese, cackling geese and American wigeon. This increase would likely have minor positive effects on waterfowl populations, because there is no shortage of short grass fields in the lower Columbia River area. The short grass fields would replace existing tall grass fields that are vegetated primarily by weedy species such as reed canarygrass and Canada thistle. Alternative 2 would also result in the creation of an additional 40 acres of nontidal wetlands, which represents an increase of 36 percent for this habitat type. These wetlands provide foraging and resting areas for geese, ducks, great blue herons and other waterbirds. The effect on local waterbird populations would be a minor positive effect. The planting of 100 acres of riparian forest (in addition to the 180 acres proposed in Alternative 1) in existing weedy fields would be expected to have a neutral effect on waterbird populations during the life of this CCP, although this forest will eventually reach maturity and likely provide nesting sites for great blue herons, wood ducks, and hooded and common mergansers.

The area open to waterfowl and snipe hunting would be increased under Alternative 2. Crims Island and Price Island would be opened to hunting along the shorelines. For all practical purposes, hunting occurs in most of this area now because the refuge doesn't own the intertidal and subtidal zones immediately adjacent to the shoreline. The exception is the 94-acre interior marsh at Crims Island, which the refuge does own. Opening the marsh would represent an actual increase in hunting opportunity. We do not believe opening the marsh would result in any increase in either hunter numbers or the number of waterfowl and snipe harvested in the Columbia River estuary. Opportunities for waterfowl hunting are plentiful in the estuary and the number of waterfowl hunters is declining in both Oregon and Washington. Thus, any negative effects on waterfowl and snipe would be minor to nonexistent. Similarly, hunter-caused disturbance to other waterbirds would be minor and temporary in nature. The refuge would propose, in coordination with the Washington Department of Fish and Wildlife, to close approximately one mile of the shoreline of Hunting Island to waterfowl and snipe hunting for safety reasons. This closure would be expected to have an overall neutral effect on waterfowl and snipe harvests in the estuary and would result in a minor reduction in hunter-caused disturbance to other water birds.

Alternative 3, like Alternative 1, proposes no change in habitat types. No additional short grass fields and nontidal wetlands would be created. Therefore, there would be no effects on waterbirds as a result of habitat changes. The area open to waterfowl hunting would be increased, identical to what is proposed in Alternative 2. As in Alternative 2, no increase in the waterfowl harvest in the estuary is expected. There would be minor and temporary hunter-caused disturbance to other waterbirds, such as great blue herons, grebes, and double-crested cormorants. Overall there would be a neutral effect on waterbirds.

4.7.2.2.2 Shorebirds

The refuge is not a major foraging or resting area for shorebirds. While up to 100,000 birds are present in the estuary during spring migration, most use sandbars and mudflats located downstream of the refuge. On the refuge, a few hundred shorebirds, mostly dunlin and western sandpipers and a few greater yellowlegs, occasionally forage in the managed wetlands and intertidal zones during spring migration. Wilson's snipes are common in short grass fields during spring.

Alternative 1 proposes no change in current refuge management practices. The existing 130 acres of nontidal wetlands and 63 acres of intertidal flats and sandbars, which provide foraging areas for shorebirds, would be maintained. Approximately 180 acres of the existing 2,384 acres of grassland would be converted to early-successional riparian forest. This would result in a minor loss of habitat for migrating Wilson's snipe, although the 680 acres of short grass fields, which are preferred by snipe, would remain unchanged. Snipe numbers on the refuge probably never exceed a few hundred individuals; therefore, we expect this minor loss of habitat to have no effect on snipe populations. Alternative 1 would be neutral in its effects on shorebirds.

Alternative 2 would provide the most benefits to shorebirds and their habitats. The creation of an additional 40 acres of nontidal wetlands would provide foraging habitat for dunlins, western sandpipers and greater yellowlegs. Foraging habitat for Wilson's snipe would be increased by the addition of 110 acres of short grass fields. The existing nontidal wetlands, tidal flats and sandbars would be maintained. A total of 280 acres of fields would be planted to early-successional riparian forest. This acreage would primarily be taken from tall grass fields, which provide habitat for Wilson's snipe. However, given the abundance of grassland habitat on the refuge and the relatively low numbers of snipe (a few hundred at most), there should be a neutral effect on snipe.

Crims and Price Island would be opened to waterfowl and snipe hunting under Alternative 2. This could result in disturbance to foraging shorebirds. However, most fall migrating shorebirds (except snipe) have already passed through the estuary prior to the start of hunting season. Waterfowl hunters space themselves widely apart, so shorebirds would still find ample foraging areas around the islands. Hunting at Crims Island could result in direct take of snipe (Price Island does not have suitable habitat for snipe), although such take would be minimal. Opening these areas is not expected to result in an increase in hunter use of the refuge or the estuary, as hunting opportunities are abundant and hunter numbers are declining. Any effects on snipe or other shorebirds from waterfowl hunter disturbance or take would be neutral overall.

Alternative 3 would be similar to Alternative 1 in that there would no changes in habitat management. Thus, Alternative 3 would have neutral effects on shorebird habitat. Like Alternative 2, Alternative 3 proposes to open Crims and Price Islands to waterfowl and snipe hunting. The effects of waterfowl hunting would be same as discussed under Alternative 2 and would be expected to have an overall neutral and temporary effect.

4.7.2.2.3 Raptors

Alternative 1 proposes no changes in refuge habitat management practices. The existing refuge habitats would be maintained, with the exception that 180 of the refuge's 2,384 acres of grassland would be converted to riparian forest. Converting grassland to forest will reduce the extent of refuge habitat for grassland raptors such as northern harriers, white-tailed kites, red-tailed hawks, and American kestrels. On the other hand, as the planted forest matures it will provide nest and perch sites for many raptor species, as well as foraging areas for woodland hunters like Cooper's and sharp-shinned hawks. The existing bald eagle habitat (tidal marshes and swamps, nontidal wetlands, and late-successional riparian forest) would be maintained as is. There would be no changes in the refuge waterfowl and snipe hunting program except the proposed Elochoman Slough closure. Alternative 1 would be neutral in its effects on raptors.

Alternative 2 provides for habitat modifications that potentially benefit many raptor species. Providing an additional 40 acres of nontidal wetlands would increase foraging habitat for bald eagles and peregrine falcons. Establishing 100 acres of riparian forest (in addition to the 180 acres proposed in Alternatives 1 and 3) would provide potential perching and nesting habitat for eagles, as well as nesting and foraging habitat for other species such as red-tailed hawks, white-tailed kites, Cooper's hawks, sharp-shinned hawks, great horned owls and screech owls. These habitat benefits to raptors would be minor in scope, given the relatively small acreages involved. The conversion of 110 acres of weedy tall grass fields to short grass fields would be expected to have neutral effects on field-hunting raptors as they use both habitats.

Price Island and Crims Island would be opened to waterfowl and snipe hunting under Alternative 2. Both islands have bald eagle and osprey nest sites and are frequented by a variety of other raptors. Hunting might cause some disturbance to raptors; however, hunting would occur along the shorelines and is already occurring on State-owned tidelands immediately adjacent to the shorelines. The existing bald eagle nest sites are screened from the shorelines by mature cottonwood and spruce trees. Nesting ospreys are quite tolerant of human presence. Opening these areas to hunting is not expected to result in an increase in the number of hunters using the general vicinity. Potential additional disturbance to raptors would be minor and temporary.

Alternative 3 is similar to Alternative 1 in that no changes are proposed in the refuge's habitat management program. The existing acreages of raptor habitat would remain unchanged except for the effects of nature. Alternative 3 would have neutral effects on raptor habitat. Alternative 3, like Alternative 2, proposes to open Price and Crims Islands to waterfowl and snipe hunting. The effects to raptors, if any, would be minor and temporary as discussed under Alternative 2.

4.7.2.2.4 Landbirds

We are using the term landbirds to describe all birds other than water birds, shorebirds and raptors. Landbirds include passerine (perching) birds, woodpeckers, gallinaceous birds, kingfishers, swifts, hummingbirds, and other birds.

Alternative 1 would result in no changes to the refuge's current habitat management program. The existing refuge habitats would be maintained, with the exception of 180 acres–of the

refuge's 2,384 acres of grasslands–that would be converted to riparian forest. Converting grassland to forest will reduce the extent of refuge habitat for grassland birds such as western meadowlark, while increasing habitat for forest birds. Initially, the newly planted forest would benefit shrub species such as yellow warbler and rufous hummingbird. As the trees mature, mid and late succession forest species such as red-eyed vireo, olive-sided flycatcher and Vaux's swift would benefit. Losses to grassland species and gains to riparian forest species would be minor because of the small amount of acreage involved. Effects from Alternative 1 would be neutral on landbirds.

Alternative 2 proposes habitat modifications that would benefit many landbird species. An additional 40 acres of nontidal wetlands would be created. These wetlands would provide habitat for a variety of species, including red-winged blackbird, marsh wren, and purple martin. The acreage of short grass fields would be increased by 110 acres, from 680 acres to 790 acres. This would benefit species such as American robin and western meadowlark. Alternative 2 also proposes planting 100 acres of riparian forest, in addition to the 180 acres proposed in all the alternatives. The additional forest will provide habitat for species such as Swainson's thrush, olive-sided flycatcher, and red-eyed vireo, among many others. The additional nontidal marsh, short grass fields, and riparian forest would result from the conversion of other habitats, principally weedy tall grass fields. Thus, the habitat for a few species, e.g., American goldfinch, common yellowthroat, and savannah sparrow, would be reduced. Any habitat manipulation results in benefits to some species and disadvantages to others. In the refuge's case, many more species would benefit than not. The overall effect of these habitat changes would be minor and positive because of the relatively small acreage involved and the relative abundance of similar habitats in the vicinity of the refuge.

There would also be changes in the refuge's hunting program under Alternative 2. The shorelines of Price and Crims Islands would be opened to waterfowl and snipe hunting. Landbirds would not be targeted by hunters (nearly all species are protected by State and Federal regulations). The presence of hunters could cause some minor disturbance, but no more so than the presence of other outdoor recreationists including birdwatchers. Nesting would not be affected because the hunting season takes place in fall and winter, outside the nesting season.

Alternative 3, like Alternative 1, proposes no change in refuge habitat management practices. Existing habitat acreages would be maintained, except for converting 180 acres of grassland to riparian forest, which is common to all alternatives. The effects of Alternative 3 on songbird habitats would be essentially neutral, similar to Alternative 1. The waterfowl hunting program would be expanded under Alternative 3, like Alternative 2, to include the shorelines of Price and Crims Islands. The effects, if any, on landbirds would be minor, as described for Alternative 2.

4.7.2.3 Effects to Mammals

All three alternatives include features (management actions) common to each alternative that could affect mammals including the following: continuation of the current habitat management program; controlled permit hunting for Roosevelt elk; predator (primarily coyotes) control to benefit CWT deer; and continuation of a public use program that includes waterfowl hunting, fishing, boating, wildlife observation, and photography.

4.7.2.3.1 Coyote

Alternative 1 would continue the current refuge habitat management program. The existing refuge habitats would be maintained with the exception of 180 acres of the refuge's 2,384 acres of grassland that would be converted to riparian forest. Maintaining improved pasture that provides foraging habitat, would benefit coyote populations. The currently approved, integrated coyote control program would continue under Alternative 1, because currently, state agencies in Oregon and Washington will not grant permits for relocating coyotes. The primary means to manage coyotes would be trapping and euthanizing (shot) as well as opportunistic shooting during January 1 to April 15 (3.5 months). Since this control program began in 1997, 72 coyotes have been removed from Julia Butler Hansen Refuge, and the number removed in any given year ranged from 1 to 21 (Table 4-17).

Table 4-17 Number of coyotes removed from the Julia Butler Hansen Refuge.

Managment Unit	Year	Number Removed
Mainland	1997	9
	1998	1
	2005	4
	2006	11
	2007	8
	2008	13
Tenasillahe Island	2004	12
	2005	6
	2006	4
	2007	5
	2008	4
Crims Island	2005	3
	2006	6
	2007	3
	2008	3

There are no known estimates of coyote populations in the counties within which the Julia Butler Hansen Refuge is located; however, coyotes are abundant and likely number in the thousands in southwest Washington and northwest Oregon. As a conservative estimate, there are more than 50,000 coyotes in Washington (WDFW 2008) and 160,000 coyotes in Oregon (USDA 1997). In both states, coyotes may be hunted year-round with no bag limits.

Under Alternative 1, the coyote population using Julia Butler Hansen Refuge would be reduced temporarily through one or more consecutive years of coyote removal. After control ends, the coyote population on Julia Butler Hansen Refuge would likely increase rapidly as transient coyotes would move into vacant territories (Windberg and Knowlton 1988) and reproductive rates would increase in response to lower densities (Connolly 1978, Knowlton 1972). The coyote population likely would increase in size (possibly pre-control level) consistent with habitat conditions and the small mammal prey base. During previous years with coyote removal on Julia Butler Hansen Refuge (see Table 4-18), coyotes quickly repopulated management units after control ceased (April 15th), where the newly established (transient) coyotes preyed upon older fawns during late summer resulting in lower CWT deer recruitment. The small numbers removed from Julia Butler Hansen Refuge would not be expected to negatively affect coyote populations locally, regionally, or nationally.

Alternative 2 would entail habitat management on Julia Butler Hansen Refuge similar to Alternative 1, except for converting 110 acres of weedy tall grass fields to short grass fields, restoring 280 acres of riparian forest, and establishing an additional 40 acres of nontidal wetland. Because coyotes would utilize all existing and new habitats on Julia Butler Hansen Refuge, there would be a greater benefit to the coyote population using Julia Butler Hansen Refuge under Alternative 2, when compared with Alternative 1

Because the coyote population repopulates so quickly after control measures implemented for only 3.5 months per year end (Alternative 1), we are proposing under Alternative 2 to implement coyote control measures year-round. Because coyote control would occur throughout the year under Alternative 2, there would initially be a greater number of coyotes removed from Julia Butler Hansen Refuge on an annual basis. It is unlikely; however, that the number of coyotes removed under Alternative 2 (a limit of 40 is proposed) would be more than twice the number of coyotes removed from the refuge under the existing control program (Table 4-17). Over time, fewer coyotes would be removed under Alternative 2, when compared with the current control program in Alternative 1, because yearlong control as proposed in Alternative 2, could achieve CWT deer population objectives quicker, with fewer consecutive years of implementing coyote control measures. Regardless, the coyote population on Julia Butler Hansen Refuge would likely increase rapidly as transients would move into vacant territories (Windberg and Knowlton 1988) and reproductive rates would increase in response to lower densities (Connolly 1978, Knowlton 1972). The coyote population would likely increase in size (possibly to pre-control levels) under Alternative 2 (similar to Alternative 1), consistent with habitat conditions and the small-mammal prey base. Even though a greater number of coyotes may be removed from refuge lands under Alternative 2 compared with Alternative 1, the number removed would not be expected to negatively affect coyote populations locally, regionally, or nationally.

Because the coyote population repopulates so quickly after control measures implemented for only 3.5 months per year end (Alternative 1), we are proposing under Alternative 3 to implement coyote control measures for 8 months per year. Under Alternative 3, we would continue the current refuge habitat management program. As a result, the effects of habitat management on coyote populations using refuge lands would be similar to those described under Alternative 1. Under this Alternative 3, there may be more coyotes removed from Julia Butler Hansen Refuge within individual years compared with Alternative 1 considering the longer period of. However, there would likely be more coyotes removed in the long-term under Alternative 1when compared to Alternative 2, because coyote control would likely be needed for more consecutive years, to achieve CWT population objectives.

4.7.2.3.2 Other Mammals

Alternatives 1 and 3 would continue the current habitat management program. As a result, there would be similar beneficial effects to habitats used by other mammals.

All three alternatives include coyote control. The primary methods of control are trapping and shooting. Both methods are reasonably selective when properly executed, but trapping may result in a small by-catch of nontarget mammals. The current refuge coyote trapping program has resulted in the take of fewer than 10 opossums and 5 raccoons per year. They were released

when possible but some were euthanized because of injuries incurred in their attempts to escape the traps. Opossums and raccoons are abundant locally, regionally and nationally. The few taken on the refuge would have no effect on opossum and raccoon populations. Other mammals would be expected to be unaffected.

In the event that a mountain lion or black bear becomes a threat to CWT deer, the individual animals would be removed by trapping by or shooting. The likelihood of trapping nontarget animals would be smaller than a coyote trapping program, due to the limited focus of trapping a single target animal (cougar or bear) rather than a group of coyotes. Because only individual mountain lions or bears would be removed on an infrequent basis, there would likely be no short-term or long-term effects to local, regional, or national populations of these large mammals.

Alternatives 2 and 3 would expand the time period for coyote control. Alternative 2 proposes year-round control when necessary to protect CWT deer and Alternative 3 proposes an annual 8 month window (January–August) for control. The by-catch might increase under either alternative. Still, the number lethally removed would be small–probably less than 20 opossums and 10 raccoons per year. The removal of such small numbers would have no effect on opossum and raccoon populations locally, regionally, or nationally. Because only individual cougars or bears would be targeted and removed on the refuge, by-catch would be much less or nonexistent, than it would for general coyote control. Other mammals would not be affected.

Alternatives 2 and 3 also propose opening the shorelines of Crims and Price Islands to waterfowl and snipe hunting. The presence of hunters could cause minor disturbance to mammals frequenting these areas. Disturbed mammals would simply move away from hunters. Hunters would only be along the shoreline. There would be a neutral effect on mammal populations.

4.7.2.4 Effects to Reptiles and Amphibians

All three alternatives include installing new tidegates at some sloughs and modifying existing tidegates at others to improve connectivity between the sloughs enclosed by dikes and the Columbia River. The new tidegates will allow more water exchange, thereby benefiting reptiles and amphibians by improving water quality in the sloughs and connecting drainage ditches. Western pond turtles and aquatic breeding amphibians such as red-legged frogs, Pacific chorus frogs, long-toed salamanders and northwestern salamanders would be the chief beneficiaries.

Alternatives 1 and 3 propose no changes to the current habitat management program. The current acreages of reptile and amphibian habitat would remain essentially unchanged. The effects on reptile and amphibian habitat would be positive and would be minor because of the limited acreage involved.

Alternative 2 would provide the greatest benefit to reptiles and amphibians. Emphasis would be placed on working with partners to restore aquatic habitat. An additional 40 acres of managed nontidal wetland would be established. These shallow, heavily vegetated marshes are preferred breeding habitat for red-legged frogs, Pacific chorus frogs, and long-toed salamanders. Riparian forest, which provides habitat for terrestrial salamanders such as ensatina and western red-back, as well as foraging red-legged frogs, would be increased by planting an additional 100 acres of

native trees. The positive impact of these habitat modifications on reptiles and amphibians would be minor because of the limited acreage involved.

4.7.2.5 Effects to Invertebrates

All three alternatives include installing new tidegates at some sloughs and modifying existing tidegates at others, to improve connectivity between the sloughs enclosed by dikes and the Columbia River. The new tidegates will allow more water exchange, thereby benefiting fresh water mussels and other aquatic invertebrates by improving water quality in the sloughs and connecting drainage ditches.

Alternatives 1 and 3 propose no changes in the habitat management program. There would be a neutral effect to invertebrate habitat.

Alternative 2 proposes planting 100 acres of riparian forest, 110 acres of short grass fields, and constructing 40 acres of nontidal wetlands. Invertebrates that thrive in these habitats, such as aquatic invertebrates in freshwater wetlands, would benefit. These habitat projects would occur in areas that are presently occupied by weedy tall grass fields. There is the potential for adversely affecting invertebrates that prefer weedy tall grass fields, such as some species of nectar-feeding insects. There are no known rare, endangered or threatened invertebrates that utilize these habitats on the refuge. The effects, if any, would be positive and minor because of the limited acreage involved.

4.7.2.6 Effects to Federally Threatened and Endangered Species

4.7.2.6.1 Fish

Thirteen species of federally listed salmon and steelhead utilize the lower Columbia River. In addition, small numbers of bull trout, a threatened species, may also be found in the Columbia River.

All three alternatives include installing new tidegates at some sloughs and modifying existing tidegates at others to improve connectivity between the sloughs enclosed by dikes (on Tenasillahe Island and the mainland) and the Columbia River. The new tidegates will allow more water exchange, thereby improving fish access and water quality in the sloughs and connecting drainage ditches. Approximately 180 acres of native trees and shrubs would be planted to establish riparian forest along the sloughs. The trees would eventually provide shade and detritus for the sloughs. Improved water quality and access passageways are expected to benefit fish in the sloughs, especially native species such as juvenile salmon, which use the sloughs for foraging and respite from river currents. Fish in the estuary would also likely benefit because the improved connectivity would result in increased export of plant detritus from the Mainland Unit and Tenasillahe Island. Detritus forms the base of the estuary food web. The overall effects on listed fish populations are expected to be difficult to detect because the affected area at the refuge is very small compared to the entire estuary.

Alternative 1 proposes no changes in the refuge habitat management, public use and CWT deer management programs. This alternative would be neither more positive nor more negative than the existing situation, including tidegate activities common to all alternatives, thus its effects on fish would be neutral.

Alternative 2 proposes establishing an additional 110 acres of short-grass fields, 100 acres of riparian forest, and 40 acres of nontidal wetlands. The additional riparian forest would improve water quality in the sloughs and drainage ditches by providing shade and detritus, thus benefiting juvenile salmon and other native fish. The additional nontidal wetlands, which drain into the sloughs, would provide invertebrates upon which juvenile salmonids forage. The habitat enhancements proposed in Alternative 2 would benefit threatened and endangered fish, but the overall benefits for listed fish populations would be difficult to detect because of the relatively small amount of refuge habitat within the entire estuary area.

Alternative 2 also proposes changes to the public use and CWT deer population management programs. The shorelines of Crims and Price Islands would be opened to hunting for waterfowl and snipe. The predator control program would be expanded, and establishing an experimental population of CWT would be emphasized. Predator control occurs mostly on land and would have a neutral effect on fish or fish habitat. Opening Crims and Price Islands to waterfowl hunting could result in slight increases in motorized boat use and water pollution in those areas. However, there would not likely be an increase in the number of hunters using the area; rather, the distribution of hunters would change somewhat. The effects, if any, on threatened and endangered fish would be neutral.

Alternative 3, like Alternative 1, proposes no changes in the refuge habitat management program, thus there would be no habitat changes that would affect fish. The area open to waterfowl hunting would be increased under Alternative 3, similar to Alternative 2. Opening Crims and Price Islands to waterfowl hunting could result in slight increases in motorized boat use and water pollution in those areas. However, there would not likely be an increase in the number of hunters using the area; rather, the distribution of hunters would change somewhat. The effects, if any, on threatened and endangered fish would be negligible. The predator control program would be expanded under Alternative 3; however, predator control occurs on land and would have a neutral effect on fish.

4.8.2.6.2 Brown Pelican, Northern Spotted Owl, Marbled Murrelet, and Streaked Horned Lark

The Brown Pelican, Northern Spotted Owl, Marbled Murrelet, and Streaked Horned Lark are known to utilize the Columbia River estuary. The refuge does not contain suitable habitat for these species and their presence on the refuge has not been documented. The occurrence of any of these birds on the refuge would likely be just a “pass through.” The alternatives as described would have an overall neutral effect on brown pelicans, northern spotted owls, marbled murrelets, and streaked horned larks.

4.7.2.6.3 Steller Sea Lion

Steller sea lions follow salmon and smelt runs in the channels of the Columbia River. They do not frequent refuge lands. All of the alternatives would be expected to have a neutral effect on Steller sea lions.

4.7.2.6.4 Columbian White-tailed Deer

Habitat and Public Use Management

For all three alternatives, strategically installing new tidegates in selected sloughs and modifying existing ones would improve water exchange, water quality (dissolved oxygen), and (more importantly for the CWT deer) drainage, to reduce the frequency and severity of flood events. Shallow flooding of the Mainland and Tenasillahe Island units is a common winter occurrence; however, deep, prolonged flood events (such as occurred winter 1996 and 2006) have resulted in substantial CWT deer mortalities, which was a major setback to population recovery in Julia Butler Hansen Refuge's secure habitats. Therefore, improved drainage may affect, but is not likely to adversely affect CWT deer, because effects to the deer population would be wholly beneficial, especially during severe flood events that have caused increased mortality in previous years.

Alternative 1 would continue the current resource management program that provides habitats to meet life-history requirements and promote recovery of CWT deer on refuge management units. Specifically, habitat management to benefit CWT deer on refuge lands includes the following: seasonal grazing and mowing to maximize palatability and nutritional quality of grasses in short grass fields; periodic disking and reseeding of short grass fields to maintain an optimal mix of palatable and nutritious grass and legume species; periodic drawdown of nontidal wetlands to promote growth of obligate and facultative wetland plants during late summer and fall; controlling invasive plants; and maintaining existing forested and riparian habitats that provide cover and browse during winter and early spring. These management activities would continue, where the acreage of each habitat type would remain essentially unchanged, except that 180 acres of grassland would be converted to riparian forest. In the long-term, the increase in riparian forest would benefit CWT deer by providing additional cover and browse on refuge lands that are protected from flooding behind dikes. (At present, only about 20 percent of the diked lands are forested. We believe the deer would benefit most if about 50 percent of the land was forested in a mosaic pattern with grassland and wetland.) Therefore, the habitat management regime for Alternative 1 may affect, but is not likely to adversely affect CWT deer, because short-, long-, and cumulative effects to the deer population would be wholly beneficial, especially considering the increased cover and browse associated with more riparian forest protected by refuge dikes.

The current wildlife dependent recreation programs, including waterfowl hunting, would continue under Alternative 1. The presence of humans may cause temporary and localized disturbance to CWT deer. Because public uses would be restricted to the perimeter of the refuge's units (shoreline waterfowl hunting on islands, wildlife viewing and hiking on perimeter

dikes), CWT deer would only need to move a short distance toward the interior of the refuge to avoid the disturbance.

Alternative 2 would provide the greatest short- and long-term benefits for the CWT deer population inhabiting secure habitats on refuge lands. The benefits Alternative 2 would provide to CWT deer, compared to Alternative 1, and based upon differences in habitat management on refuge lands, follow.

Habitat Management	Benefit for CWT deer
• Establish 100 acres of riparian forest (in addition to 180 acres proposed by all alternatives).	• Greater all-season cover and browse
• Increase the extent of short grass fields 110 acres.	• More widely distributed high quality grass and legume forage
• Add 40 acres of nontidal wetlands.	• More high quality grass and forb forage during late summer and fall.

In summary, habitat management under Alternative 2 may affect CWT deer, but is not likely to adversely affect CWT deer, because short-, long-, and cumulative effects to the deer population would be wholly beneficial by providing additional all-season cover and high quality forage.

Wildlife-dependent recreation opportunities would increase under Alternative 2 compared to Alternative 1. The Service would work with Wahkiakum County to make Brooks Slough Road, which is presently open to motor vehicle traffic, a hiking/bicycling multi-use trail. At the same time, the Center Road hiking trail would be closed to public access. Brooks Slough Road is expected to be more popular than Center Road as a hiking trail. Therefore, the number of refuge visitors may increase in the short-term and long-term. Also, the shorelines of Price and Crims Islands would be open to waterfowl hunting. For the most part, hunting is already occurring in or adjacent to these areas because State-owned tidelands, which abut refuge lands, are open to hunting. Increases in hiking, biking and hunting could result in increased disturbance to CWT deer. Brooks Slough Road lies along the perimeter of the Mainland Unit. If disturbed, deer would be expected to move a short distance toward the interior of the refuge during times of high visitor use. Deer on Price and Crims Islands would do likewise. From available scientific information, white-tailed deer are generally tolerant of moderate human disturbance. They often live in suburban neighborhoods and city parks, where human presence is nearly constant (Etter 2002, Harveson et al. 2007). The relatively minor disturbance caused by hunters, hikers, and bicyclists using perimeter areas would cause temporary and localized disturbance to CWT deer.

In contrast with Alternative 1, under Alternative 2 we would also increase efforts to reintroduce CWT deer to areas of suitable habitat upstream of Julia Butler Hansen Refuge. Historically, CWT deer occupied the entire lower Columbia River floodplain from the Columbia Gorge to the river's mouth and the lower Willamette River valley. Reintroductions previously occurred on Crims, Fisher, and Lord Islands, which are located 22-25 miles upstream of refuge lands. Other potential reintroduction sites include Cottonwood Island (near Longview and Kelso, Washington) and Ridgefield National Wildlife Refuge (near Vancouver, Washington). Successful reintroductions would increase CWT deer range and establish additional populations in secure habitat. The reintroductions would reduce the risk of extinction and promote delisting

and recovery of CWT deer. In the long-term, reintroductions would be wholly beneficial to the CWT deer population in the lower Columbia River.

Alternative 3 would continue the current refuge habitat management program as described under Alternative 1. As a result, the effects on CWT deer would be the same as discussed for Alternative 1.

Wildlife-dependent recreational opportunities would increase under Alternative 3, compared to Alternatives 1 and 2. Specifically, the shorelines of Crims and Price islands would be opened to waterfowl hunting. Additionally, the Service would seek agreement with Wahkiakum County to designate Brooks Slough Road a multi-use hiking/biking trail. The effects on CWT deer would be the same as discussed for Alternative 2.

Mammalian Predator Management

Lethal removal of mountain lions and black bears when found on refuge lands would beneficially effect the CWT deer population on the refuge. These large mammalian predators could prey upon juvenile and adult deer and substantially reduce deer numbers if they are not removed from refuge lands. Because removal of mountain lions and bears could occur under Alternatives 2 and 3, short- and long-term benefits to the CWT deer populations on refuge management units would be greater compared with Alternative 1.

Stochastic simulation modeling was conducted for CWT deer on the Mainland and Tenasillahe Island units using methods described in Phillips and White (2003). This modeling was specifically used to compare effects of coyote control on deer population size on Julia Butler Hansen Refuge relative to the Draft CCP/EIS alternatives. Primary population parameters for the stochastic modeling were–estimated survival and recruitment rates and their process standard deviations, as well as initial population size (N_0), correlation among age-sex-specific survival rates, duration in years of coyote control, and effect of coyote removal on CWT deer recruitment (dR). Estimated survival rates ($\hat{S}_J$, $\hat{S}_D$, and $\hat{S}_B$) for the Mainland and Tenasillahe Island units were derived from the optimized deterministic models (see Section 4.5.3.2.3). Because population data from Julia Butler Hansen Refuge were not sufficient to estimate process standard deviation for survival rates, values for mule-deer juvenile and adult survival from Unsworth et al. (1999) were used for deterministic modeling.

The short-term effects of coyote control on the Mainland and Tenasillahe Island units were estimated as the average difference in recruitment (d$R(t)$) values, between consecutive years with coyote control and an equal number of years preceding coyote control on Julia Butler Hansen Refuge.

$$dR = \frac{\sum R(t)_C - \sum R(t)_{NC}}{7} = 0.30 \text{ fawns/doe,}$$

Specifically, where subscript C signified years with coyote control (1997, 1998, and 2006 at the Mainland Unit and 2004–2007 at Tenasillahe Island Unit); and NC signified years without coyote control, immediately before years with coyote control (1995, 1996, and 2005 at MU and 2000−2003 at TIU). Two values of N_0 for each refuge management unit were used for modeling

based data from the aerial classification survey conducted during March 2007. The two N_0 values represented the minimum and maximum population estimates for the March 2007 herd size, where minimum counts were not adjusted for sighting probability but "minimum + ½ probable" counts were adjusted.

Simulation models for the Mainland (M) and Tenasillahe Island (T) units were conducted based upon the following two coyote removal cases: M30 and T30–coyote removal resulting in dR = 0.30 fawns per doe and M45 and T45–coyote removal resulting in dR = 0.45 fawns per doe. In the second case, the ratio was the maximum observed increase in recruitment following 1 year of coyote control on either refuge unit (0.45 fawns per doe at M during 1997). These cases were evaluated in the stochastic model given the following N_0 values: 51 and 65 for the Mainland Unit, and 71 and 90 for the Tenasillahe Island Unit. Outputs (population trajectories) were generated for case × N_0 × end year (5, 10, 15, and 20 years) combinations by running 100,000 simulations of the stochastic model using SAS (SAS Institute). Modeling population projections were limited to 20 years because available refuge data did not support inclusion of density dependent factors and it coincided with horizons for refuge management planning.

Stochastic modeling was used to estimate probabilities (percent) of extirpation as well as achieving N_t greater than or equal to (≥) 125 and $N_t \geq N_0$ based on percentiles of projected population sizes. For cases with coyote removals, the number of consecutive removal years required to achieve $N_t \geq 125$ with 50 percent and 90 percent probability given dR_{mean} = 0.30 fawns per doe and dR_{max} = 0.45 fawns per doe were also evaluated. The stochastic model was also used to estimate levels of R required to achieve or exceed $N_t \geq 125$ and $N_t \geq N_0$ with 50 percent and 90 percent probability at 10 years.

The behavior of the stochastic model with coyote control simulated for 10 years under case M30 (Alternatives 1 and 3) is depicted in Figure 4.5. Populations starting at N_0 = 51and 65 exhibited nearly linear growth at the 50th percentile during years with coyote control. When coyote removal ended, $R(t)$ reverted to $\hat{R}$, and the CWT deer populations declined on the Mainland Unit. Median and 10th percentile lines depict population size above which 50 percent and 90 percent of simulated population sizes occurred corresponding to probability levels of interest related to herd management on Julia Butler Hansen Refuge (see Tables 4-18 and 4-19).

Simulated coyote control used in consecutive years for case M30 (Alternatives 1 and 3) was not adequate to achieve $N_t \geq 125$ deer where t=20 years with probability ≥ 0.90 percent (Table 4-18). $N_t \geq 125$ was selected for the stochastic modeling because it represented approximate CWT deer population objectives for the Mainland and Tenasillahe Island units. However, ≥ 50 percent of population simulations were ≥ 125 within 15 years. In contrast, 90 percent of population simulations reached 125 deer within 15 years (50 percent achieved this population level within 8 years) for case M45 (Alternative 2) because there was a larger increase in the fawns per doe ratio from more intensive coyote control compared with M30. Stochastic modeling indicated approximately triple the historic, long-term R was required for 90 percent of the Mainland Unit population simulations to reach 125 deer in 10 years ($\hat{R}$ = 0.307 to fitted R of 0.811 or 0.911 fawns per doe depending on N_0 [Table 4-19]). Approximately doubling $\hat{R}$ was required for 50 percent of population simulations to reach 125 deer (0.626 or 0.692 fawns per doe) or to ensure a high probability (90 percent) of population growth (0.620 or 0.625 fawns per doe) in 10 years.

Mean *R* had to increase by nearly 50 percent over historic levels (about 0.45 fawns per doe) providing equal probability of population growth or decline (stable population) after 10 years.

The herd on the Tenasillahe Island Unit would grow to 125 deer more quickly under simulated coyote control compared to the Mainland Unit herd (Table 4-18). For case T30 (Alternatives 1 and 3), $N_t \geq 125$ was achieved in 3–11 years depending on N_0 and desired confidence (50 or 90 percent probability). For case T45 (Alternative 2), $N_t \geq 125$ was achieved after 2–7 years. Given 10 years to achieve $N_t \geq 125$, the required mean *R* ranged 0.446–0.679 fawns per doe (Table 4-19), which represented a 29–97 percent increase over $\hat{R} = 0.345$ fawns per doe. Only 6–50 percent increases in mean R were required to achieve $N_t \geq N_0$ after 10 years.

Figure 4.5 Percentiles of population size distributions of CWT deer projected from a stochastic model of the Mainland Unit herd in northwest Oregon and southeast Washington. Note: Coyote control was simulated for years 1–10 by an increase of 0.3 fawns per doe above baseline (0.307 fawns per doe) followed by 10 years without coyote control.

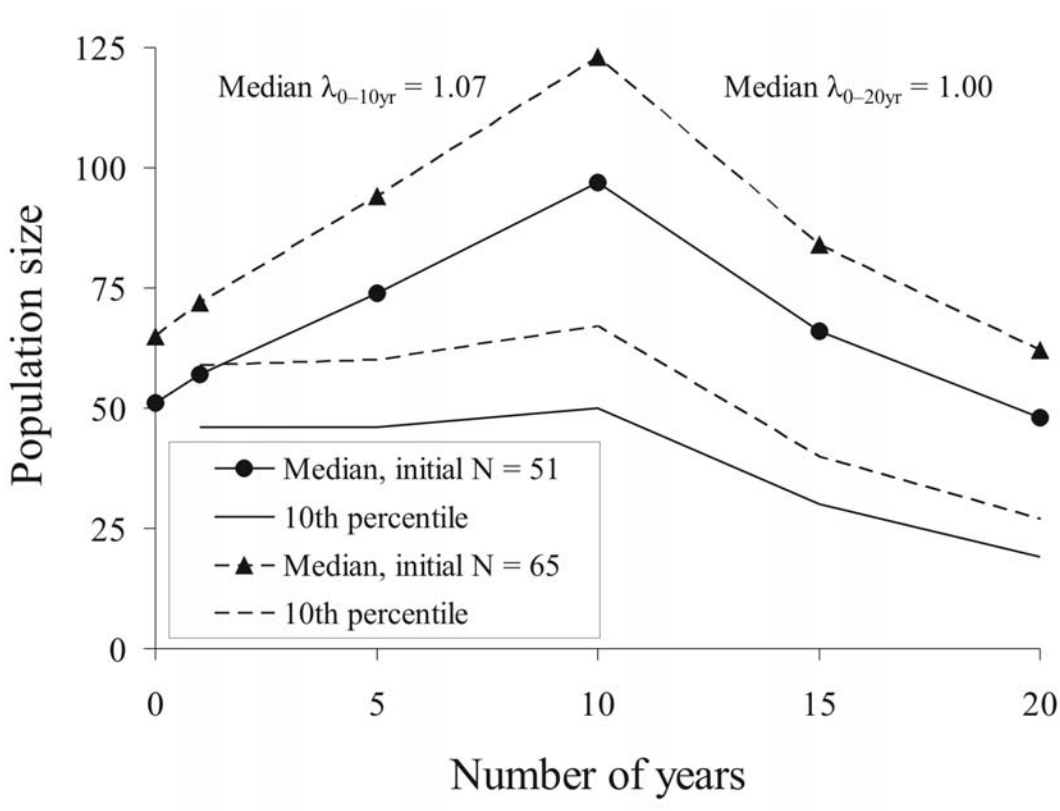


Table 4-18 Estimated years of consecutive coyote control required to achieve greater than or equal to 125 CWT deer at Julia Butler Hansen Refuge[a] in northwest Oregon and southeast Washington.

Management Unit	Case[a]	Percent of Population Simulations	N_0[b]	Years of Coyote Control
Mainland	M30	90	51	more than 20
			65	more than 20
		50	51	15
			65	11
	M45	90	51	15
			65	12
		50	51	8
			65	5
Tenasillahe Island	T30	90	71	11
			90	8
		50	71	5
			90	3
	T45	90	71	7
			90	5
		50	71	4
			90	2

[a]Simulation models for the Mainland (M) and Tenasillahe Island (T) units were conducted based upon the following two coyote removal cases: M30 and T30 coyote removal resulting in $dR = 0.30$ fawns per doe; and M45 and T45 coyote removal resulting in $dR = 0.45$ fawns per doe.
[b]Initial population values (N_0) represent minimum and maximum herd size population estimates from March 2007.

Table 4-19 Mean fawn per doe ratios (*R*) required over 10 consecutive years to achieve management objectives of 90 percent or 50 percent of simulated[a] populations with ≥ 125 CWT deer at Julia Butler Hansen Refuge in northwest Oregon and southeast Washington.

Management Unit	Population	Percent of Population Simulations	N_0[b]	Mean *R* Fitted	Mean *R* Case	Mean *R* Δ
Mainland	$N \geq 125$	90	51	0.911	0.307	0.604
			65	0.811	0.307	0.504
		50	51	0.692	0.307	0.385
			65	0.626	0.307	0.319
	$N \geq N_0$	90	51	0.625	0.307	0.318
			65	0.620	0.307	0.313
		50	51	0.449	0.307	0.142
			65	0.451	0.307	0.144
Tenasillahe Island	$N \geq 125$	90	71	0.679	0.345	0.334
			90	0.604	0.345	0.259
		50	71	0.511	0.345	0.166
			90	0.446	0.345	0.101
	$N \geq N_0$	90	71	0.517	0.345	0.172
			90	0.506	0.345	0.161
		50	71	0.364	0.345	0.019
			90	0.365	0.345	0.020

[a]Each case × N_0 × year combination was based on 100,000 simulated population trajectories.
[b]The initial population values (N_0) represent the minimum and maximum population estimates for the herd size from March 2007.

Summary

The greatest short- and long-term benefits to the CWT deer population utilizing refuge lands would likely be realized by implementing management strategies proposed in Alternative 2. There would be more habitats available on refuge lands to meet the life-history needs of the deer, especially considering increased acres of foraging habitat (improved pastures) behind dikes protected from flooding. Moreover, a year-round coyote control program (when annually needed based upon criteria) and removal of mountain lions and black bears (when present) would maximize the recruitment of young as well as survival of yearlings and adults that would be needed to achieve population objectives for refuge management units. Because the predator management program under Alternative 2 would likely achieve CWT deer population objectives in fewer years, compared with Alternatives 1 and 3, there would be fewer coyotes removed from the refuge in the long-term under Alternative 2.

4.7.2.7 Effects to Wetland Habitats and Associated Wildlife

Wetland habitats within the refuge include tidal marsh, tidal swamp, tidal open water, sloughs and nontidal wetlands. All of the alternatives propose protection of the existing wetlands. Invasive species would be controlled to preserve the native vegetation and wildlife of the Columbia River estuary. Management of tidal wetlands would consist of regulation of public use, invasive species control, wildlife and vegetation monitoring, research, and working with partners to protect the biological integrity and diversity of the estuary.

All three alternatives include installing new tidegates at some sloughs and modifying existing tidegates at others to improve connectivity between the sloughs enclosed by dikes (on Tenasillahe Island and the Mainland Unit) and the Columbia River. The new tidegates would allow more water exchange, thereby improving water quality in the sloughs and connecting drainage ditches. All native wildlife associated with the sloughs would benefit. Greater water exchange would also improve the flow of detritus and other nutrients from the sloughs to the estuary, thereby benefiting plant and animal life in the estuary. The benefits would not be considered significant because of the relatively small scale of the project when compared to the Columbia River estuary as a whole.

Alternative 1 proposes no changes to the existing habitat management program. No additional wetlands would be restored. The existing wetland acreages would continue to be managed as described above. The existing public use program, including waterfowl hunting, would continue unchanged. Hunters and hikers could potentially damage wetland habitat by trampling vegetation. Any such effects are minor and inconsequential, and would have a neutral effect overall because hiking is restricted to perimeter roads and hunting is highly dispersed, affecting only small areas.

Alternative 2 provides for the restoration of an additional 40 acres of nontidal wetland. These wetlands would provide forage for waterfowl, habitat for amphibians and aquatic invertebrates, and forage for CWT deer. The effects to wetlands and wetland wildlife would be beneficial, but they would not be considered significant because of the small acreage.

The public use program would be expanded under Alternative 2 by potentially converting Brooks Slough Road to a hiking/biking trail and opening the shorelines of Crims and Price Islands to waterfowl hunting. Increased hiking and biking on Brooks Slough Road would have no effect on wetland habitat. Hunters might trample some wetland vegetation at Crims and Price Islands; however, trampling would occur at such small, dispersed areas that overall effects on wetland habitat would be neutral.

Alternative 3, like Alternative 1, proposes no changes to the existing habitat management program. The effects of the habitat management program to wetland habitats would be the same as Alternative 1. The public use program would be expanded under Alternative 3, similar to Alternative 2, and the effects would be neutral.

4.7.2.8 Effects to Riparian (Nontidal) Habitats and Associated Wildlife

All three alternatives propose converting 180 of the refuge's 2,384 acres of grasslands to riparian forest to benefit CWT deer, other mammals, amphibians and birds. Fish and other aquatic life would also benefit because the forest would provide detritus that fuels the food chain in the sloughs and the estuary. Grassland species would lose a small amount of habitat; however, more than 2,200 acres would remain. Effects would be positive yet minor overall because of the small acreage involved.

Alternative 1 would continue the existing habitat management program. The present acreages of grassland and riparian forest would be maintained, except for the 180 acres of additional riparian forest. Public use would also continue unchanged. Effects to riparian habitats and wildlife would be minor and positive under Alternative 1.

Alternative 2 proposes increasing the acreage of short grass fields by 110 acres, from 680 acres to 790 acres. This would benefit CWT deer, Canada geese, and other birds. Alternative 2 also proposes planting 100 acres of riparian forest, in addition to the 180 acres proposed in all of the alternatives. The additional forest will provide habitat for CWT deer and other woodland wildlife. The additional short grass fields and riparian forest would result from the conversion of other habitats, principally weedy tall grass fields. Thus, the habitat for a few species, e.g., American goldfinch, common yellowthroat, and savannah sparrow, would be reduced. Any habitat manipulation results in both winners and losers. In the refuge's case, many more species would benefit than would lose. Most importantly, the CWT deer would benefit. The overall effect of these habitat changes would be positive for acreage involved.

Alternative 2 also provides for developing Brooks Slough Road into a multi-use hiking/biking and auto tour trail, if an agreement can be negotiated with Wahkiakum County. Hiking and biking would be restricted to the existing road; the speed limit would be reduced, so there would be no effect on riparian habitat.

Alternative 3, like Alternative 1, proposes no changes in the existing refuge habitat management program. The public use program would be expanded, similar to Alternative 2. Effects to riparian habitats and wildlife would be the same as Alternative 1.

Management of the refuge is focused on maintaining the existing habitats. Most of the refuge consists of wetlands that are some of the best remaining native habitats in the estuary. Therefore, neither of the alternatives proposes habitat manipulation, other than invasive species control. The existing acreage for each habitat type would remain unchanged, except for changes that might occur as a result of natural processes.

4.7.3 Lewis and Clark Refuge

4.7.3.1 Effects to Fish

Alternative 1 protects habitats used directly by fish species at the refuge, primarily tidally influenced sloughs, marshes, tidal flats, and shallow subtidal floodplains used for juvenile rearing. These habitats also indirectly provide benefits to fish through production and export of nutrients, organic matter, and invertebrates, which contribute to the food web in the estuary.

Alternative 2 would potentially provide greater indirect benefits to fish. Additional emphasis would be placed on working with partners to share resources, training and equipment to control invasive species. Nonnative, invasive plants and animals may degrade the estuary's productivity and negatively affect the food web for fish. Prompt and effective control of invasive species may prevent such consequences. The Service would meet with ODSL to discuss management options for State lands, including tidelands, located within the refuge boundary. An agreement between the Service and the State to include these lands in the refuge, or outright acquisition of the lands by the Service, would provide a higher level of protection for fish habitat.

Alternative 2 would also provide for additional interpretive signs in the refuge and the creation of a water trail. These actions might result in increased public use, especially by nonmotorized watercraft, but no effects on fish would be expected. Public visits to the refuge also involve the use of motorized watercraft which typically release small amounts of petroleum residues into the water. We are not aware of any evidence that such small amounts of residue are harming fish in the estuary. Most water in the refuge is classified as navigable and under the jurisdiction of the State of Oregon, thus we could not restrict boat traffic in an effort to reduce boat pollution. Overall, Alternative 2 would result in beneficial effects to fish, although these effects would be small and indirect.

4.7.3.2 Effects to Birds, Mammals, Reptiles, Amphibians and Invertebrates

Alternative 1 proposes no changes in the refuge habitat management, resource management or public use programs. This alternative would have neither positive nor negative effects compared to the existing situation, thus its effects on wildlife would be neutral.

Alternative 2 potentially would provide greater indirect benefits to wildlife. Additional emphasis would be placed on working with partners to share resources, training, and equipment to control invasive species. Nonnative, invasive plants and animals may degrade the estuary's wildlife habitats. For example, purple loosestrife is threatening to displace much of the native vegetation in the tidal marshes. Purple loosestrife provides no forage for waterfowl, whereas the native

plants it is displacing produce the seeds, tubers, and foliage that sustain waterfowl. Control of invasive species like purple loosestrife would maintain plant diversity and wildlife food sources.

Under Alternative 2, the Service would meet with ODSL to discuss management options for State lands, including tidelands, located within the refuge boundary. An agreement between the Service and the State to include these lands in the refuge, or outright acquisition of the lands by the Service, would provide a higher level of protection for wildlife habitat. For example, camping is allowed on State-owned islands, but not on islands that are part of the refuge. The presence of people and dogs on the islands on a 24-hour basis results in disturbance to waterfowl, raptors, and other wildlife that use the islands and nearby waters.

Alternative 2 would also provide for additional interpretive signs on the refuge and creation of a water trail. These actions may result in increased public use, especially by nonmotorized watercraft, which could result in increased disturbance to wildlife. Alternatively, interpretive displays and a water trail would be expected to focus public use on a small part of the refuge, away from sensitive bird nesting areas, thus leaving large areas undisturbed. Most wildlife could move a short distance to avoid disturbance. Thus the effects of disturbance from increased public visitation are expected to be minor and not significant. Public visits to the refuge may also involve the use of motorized watercraft which typically deposit small amounts of petroleum residues in the water. We are not aware of any evidence that such residues are harming wildlife in the estuary. Most water in the refuge is classified as navigable and under the jurisdiction of the State of Oregon, thus we could not restrict boat traffic in an effort to reduce boat pollution.

Overall, Alternative 2 would result in minor beneficial effects to wildlife, although these effects would be neutral.

4.7.3.3 Effects to Federally Threatened and Endangered Species

4.7.3.3.1 Fish

Thirteen species of federally listed salmon and steelhead utilize the lower Columbia River. In addition, small numbers of bull trout, a threatened species, may also be found in the Columbia River. Alternative 1 proposes no changes in the refuge habitat management, resource management, or public use programs; therefore, there would be a neutral effect to fish from Alternative 1.

Alternative 2 potentially would provide greater indirect benefits to listed salmonids and bull trout. Additional emphasis on working with partners to share resources, training, and equipment to control invasive species would occur. Nonnative, invasive plants and animals may degrade the estuary's productivity and negatively affect the fish food chain. Prompt and effective control of invasive species may prevent such consequences. We would meet with ODSL under Alternative 2, to discuss management options for State lands, including tidelands, located within the refuge boundary. An agreement between the Service and the State to include these lands in the refuge, or outright acquisition of the lands by the Service, would provide a higher level of protection for fish habitat. Alternative 2 would also provide for additional interpretive signs on the refuge and creation of a water trail. These actions might result in increased public use,

especially by nonmotorized watercraft, but no effects on fish are expected. Public visits to the refuge may involve the use of motorized watercraft which typically release small amounts of petroleum residue into the water. We are not aware of any evidence that residues are harming fish in the estuary. Most water in the refuge is classified as navigable and under the jurisdiction of the State of Oregon, therefore, we could not restrict boat traffic in an effort to reduce boat pollution. Overall, Alternative 2 would result in beneficial effects to listed fish.

4.7.3.3.2 Brown Pelican, Northern Spotted Owl, Marbled Murrelet, and Streaked Horned Lark

Brown pelicans occasionally forage in waters around Lois and Miller Sands Islands, at the downstream end of the refuge. Typically, only a few pelicans are present for short periods of time. They are not known to roost on refuge lands. Neither alternative would be expected to affect brown pelicans.

Northern spotted owls are not known to occur on the refuge. The only refuge unit with potentially suitable habitat is Tongue Point, which consists of uneven age forest dominated by old growth Douglas fir and western hemlock. However, the minimum home range size of spotted owl pairs in the Oregon coast range is typically greater than 1,400 acres (Thomas et al. 1990). Tongue Point encompasses only 70 acres and is surrounded by habitat that is unfavorable for spotted owls (the Columbia River, a large Job Corps center, and a Coast Guard station); therefore, it is highly unlikely that spotted owls would occupy the site.

Marbled murrelets are not known to nest or forage within the refuge. Tongue Point, with its large old growth trees, contains potentially suitable nesting habitat, but surveys by refuge staff have not detected the presence of marbled murrelets.

Streaked horned larks are commonly present at Rice Island, Miller Sands Spit, and Pillar Rock Island. These dredge spoil-created islands support the sparsely vegetated habitat preferred by streaked horned larks (Pearson and Hopey 2005). Although within the refuge boundaries, the islands are presently owned and managed by the State of Oregon.

Alternative 1 proposes no changes in the refuge's habitat management, resource management or public use programs. This alternative would have neither positive nor negative effects compared to the existing situation, thus its effects on streaked horned larks would be neutral.

Alternative 2 proposes that the Service meet with ODSL to discuss management options for State lands located within the refuge boundary. An agreement between the Service and the State to include these lands in the refuge, or outright acquisition of the lands by the Service, would provide a higher level of protection for streaked horned lark habitat. For example, camping is allowed on State-owned islands, but not on islands that are part of the refuge. The presence of people and dogs on the islands on a 24-hour per day basis may be a disturbance to streaked horned larks and may disrupt nesting, although we are aware of no site specific studies on this subject. Alternative 2 would also provide for additional interpretive signs on the refuge and creation of a water trail. A water trail would not be located close to the dredge spoil islands; therefore, no effects on streaked horned larks are expected. Overall, Alternative 2 could be beneficial for streaked horned larks, but the effects would be neutral.

4.7.3.3.3 Steller Sea Lion

Steller sea lions follow salmon and smelt runs migrating upstream in the channels of the Columbia River. They haul out to rest, along with California sea lions and harbor seals, on sandbars within refuge boundaries.

Alternative 1 proposes no changes in the refuge habitat management, resource management or public use programs. This alternative would have neither positive nor negative effects compared to the existing situation, thus its effects on Steller sea lions would be neutral.

Alternative 2 proposes additional interpretive signage and the creation of a water trail in the refuge. Public use might increase as a result and lead to increased disturbance to resting Stellar sea lions. This effect would be expected to be small and not significant. At any rate, the waters surrounding sea lion haul outs are classified as navigable waterways and the refuge has little to no jurisdiction over boat traffic. Alternative 2 also proposes that the Service seek either an agreement to manage State-owned lands or acquire State-owned lands in the refuge. Either action would not affect Steller sea lions, thus Alternative 2's effects would be neutral.

4.7.3.3.4 Columbian White-tailed Deer

The habitat on most of the refuge islands is unsuitable for CWT deer because of daily tidal flooding. Columbian white-tailed deer have been observed on Welch and Karlson Islands. Part of Karlson Island was formerly diked and supported a few resident CWT deer; however, the dikes were breached in the 1970s, and the island is now flooded during high tides. There is no evidence of a resident population of CWT deer on either island at the present time, although Welch Island, and perhaps other refuge islands, probably receive temporary use by CWT deer from nearby Tenasillahe Island.

Alternative 1 proposes no changes in the refuge's habitat management, resource management, or public use programs and thus there would be a neutral effect to CWT deer.

Alternative 2 potentially would provide greater indirect benefits to wildlife including CWT deer. Additional emphasis would be placed on working with partners to share resources, training, and equipment to control invasive species. Nonnative, invasive plants and animals may degrade the estuary's wildlife habitats. The potential effects of such habitat degradation on CWT deer are not known, but it is expected that the deer would better thrive in a healthy habitat with native plants and animals.

Under Alternative 2, the Service would meet with ODSL to discuss management options for State lands, including tidelands, located within the refuge boundary. An agreement between the Service and the State to include these lands in the refuge, or outright acquisition of the lands by the Service, would provide a higher level of protection for wildlife habitat. There would be a neutral effect on CWT deer because the State lands in the refuge do not have suitable habitat for the deer.

Alternative 2 would also provide for additional interpretive signs on the refuge and creation of a water trail. These actions might result in increased public use and thus increased disturbance to CWT deer. Public use would occur almost entirely on the water because the swampy ground and thick vegetation on the islands discourages hiking. To avoid disturbance from public us on the water, CWT deer would simply move a short distance inland. Because few CWT deer use the refuge, there would be a neutral effect on the population as a whole.

4.7.3.4 Effects to Wetland Habitats and Associated Wildlife

Wetland habitats within the refuge include tidal marsh, tidal scrub-shrub swamp, tidal Sitka spruce swamp, tidal cottonwood/willow swamp, mud flats and sandbars, and open water. Neither alternative proposes any direct changes to habitats, except invasive species control. The refuge encompasses most of the best remaining native habitats of the Columbia River estuary. The management goal is to preserve these habitats and allow natural processes to function unimpeded.

Alternative 1 proposes no changes in the refuge's habitat management, resource management, or public use programs; therefore, there would not be any changes in effects to wetlands and associated wildlife, resulting in an overall neutral effect.

Alternative 2 potentially would provide greater indirect benefits to wetland habitats and wildlife. Additional emphasis would be placed on working with partners to share resources, training and equipment to control invasive species. Nonnative, invasive plants and animals may degrade the estuary's wildlife habitats. For example, purple loosestrife is threatening to displace much of the native vegetation in the tidal marshes. Purple loosestrife provides no forage for waterfowl, whereas the native plants it is displacing produce the seeds, tubers, and foliage that sustain waterfowl. Control of invasive species like purple loosestrife would maintain plant diversity and wildlife food sources.

Under Alternative 2, the Service would meet with ODSL to discuss management options for State lands, including tidelands, located within the refuge boundary. An agreement between the Service and the State to include these lands in the refuge, or outright acquisition of the lands by the Service, would provide a higher level of protection for wetland habitat.

Alternative 2 would also provide for additional interpretive signs on the refuge and creation of a water trail. These actions might result in increased public use, which could result in increased trampling of vegetation and disturbance to wildlife. Any such effects would be minor and temporary, because the swampy ground and vegetation of the wetland habitats discourages foot travel.

Overall, Alternative 2 would result in beneficial effects to wetland habitats and wildlife, although the overall effects would be neutral.

4.7.3.5 Effects to Riparian and Upland Habitats and Associated Wildlife

Riparian and upland habitats within the refuge include riparian forest, upland conifer and mixed forest, and upland dredge spoil islands. Neither alternative proposes any direct changes to habitats, except invasive species control as needed. The refuge encompasses most of the best remaining native habitats of the Columbia River estuary. The management goal is to preserve these habitats and allow natural processes to function unimpeded.

Alternative 1 proposes no changes in the refuge's habitat management, resource management, or public use programs and thus there would not be any changes in effects, resulting in an overall neutral effect to riparian and upland habitats and associated wildlife.

Alternative 2 potentially would provide greater indirect benefits to riparian and upland habitats and wildlife. Additional emphasis would be placed on working with partners to share resources, training, and equipment to control invasive species. Nonnative, invasive plants and animals may degrade the estuary's wildlife habitats. For example, the shrub scotch broom invades dredge spoil islands and suppresses the growth of native grasses, shrubs, and trees. Control of invasive species like scotch broom would maintain plant diversity and wildlife food sources.

Under Alternative 2, the Service would meet with ODSL to discuss management options for State lands, including riparian forest located within the refuge boundary. An agreement between the Service and the State to include these lands in the refuge, or outright acquisition of the lands by the Service, would provide a higher level of protection for riparian habitat.

Alternative 2 would also provide for additional interpretive signs on the refuge and creation of a water trail. These actions might result in increased public use, which could result in increased trampling of vegetation and disturbance to wildlife. Any such effects would be minor and temporary, because the thick vegetation of the riparian habitats discourages foot travel. Overall, Alternative 2 would result in neutral effects to riparian and upland habitats and wildlife.

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