INVENTORY OF RIPARIAN HABITATS

AND ASSOCIATED WILDLIFE ALONG COLUMBIA AND SNAKE RIVERS

U.S. ARMY CORPS OF ENGINEERS
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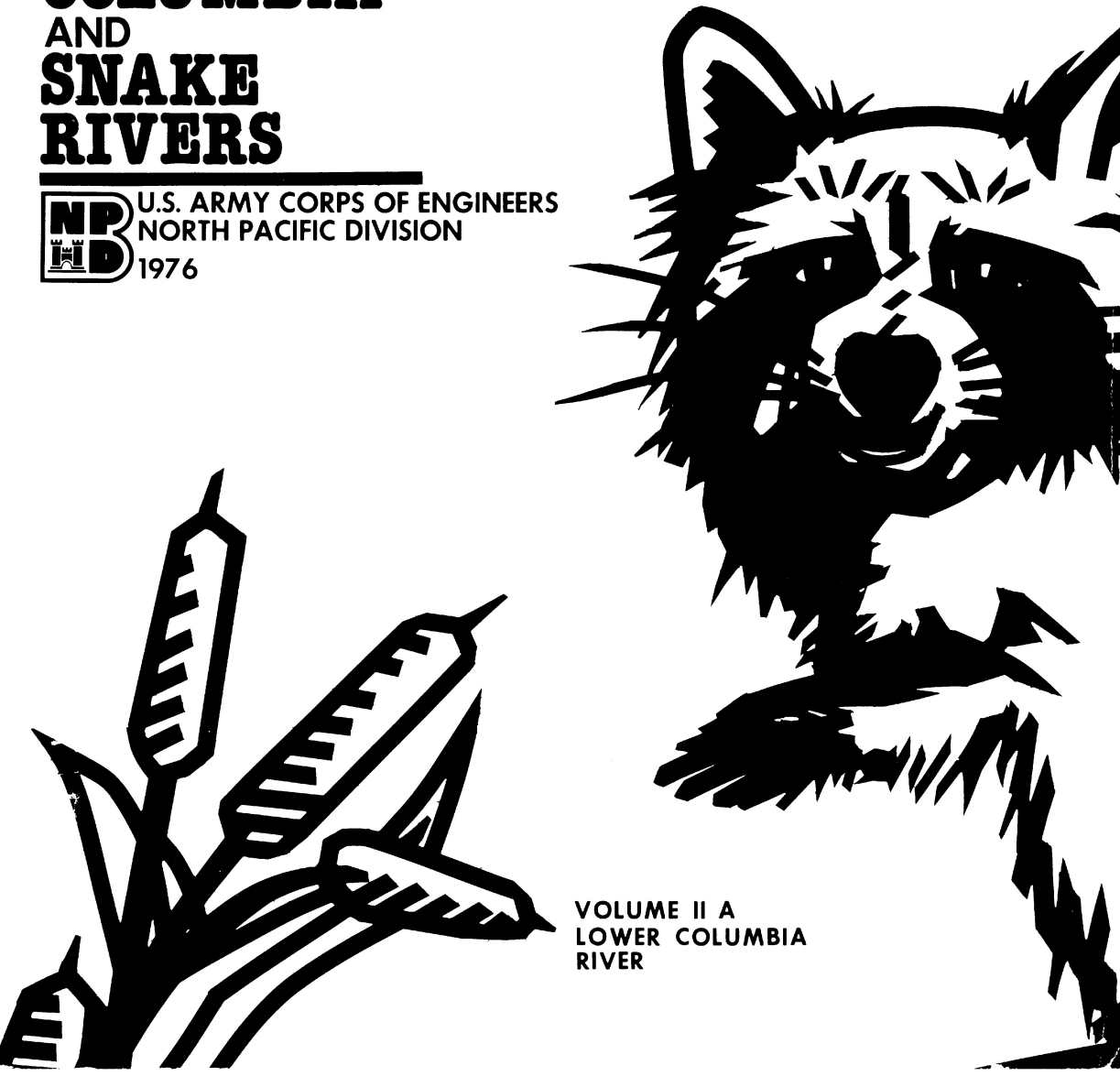

VOLUME II A
LOWER COLUMBIA
RIVER

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INVENTORY OF RIPARIAN HABITATS AND ASSOCIATED WILDLIFE ALONG THE COLUMBIA RIVER

to

U.S. Army Corps of Engineers

Wildlife Work Group

from

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ABSTRACT

Inventory of wildlife, wildlife habitat, and human use of wildlife resources associated with the Columbia River from RM (river mile) 0-292 was conducted April 1973-October 1975. The study area was broken down into the following six segments: (1) RM 0-12, (2) RM 12-79, (3) RM 79-145, (4) RM 145-192 (Bonneville Pool), (5) RM 192-215.6 (The Dalles Pool), and (6) RM 215.6-292 (John Day Pool).

Vegetative types and land form classes (habitats) within the study area were identified. Sampling of vegetation, wildlife populations, and human use of wildlife resources was stratified on the basis of habitat and segments of the study area.

The study was divided into the following sub-studies primarily on the basis of compatibility of inventory methods: (1) delineation of broad vegetative types and land form classes, (2) description of vegetative communities, (3) inventory of big game, (4) inventory of waterfowl, (5) inventory of aquatic furbearers, (6) inventory of terrestrial furbearers, (7) inventory of birds other than waterfowl, (8) inventory of small mammals, (9) inventory of marine mammals, (10) inventory of bats, (11) inventory of reptiles and amphibians, (12) inventory of human use of wildlife resources, and (13) preliminary assessment of the effects of peaking on wildlife and wildlife habitat.

VEGETATIVE TYPES AND LAND FORM CLASSES

Twenty-seven habitats (vegetative types and land form classes) were identified in segment 1, 36 in segment 2, 27 in segment 3, 48 in segment 4, 43 in segment 5, and 57 in segment 6. Seventy-five percent of the total acres in each segment consist of the following habitats, listed in order of amount of acres:

Segment 1: (1) tidal marsh; (2) beachgrass; (3) sand; (4) grassland; (5) residential; (6) alder; and (7) pasture.

Segment 2: (1) tidal marsh; (2) shrub willow; (3) willow/cottonwood, large trees; (4) grassland; (5) cottonwood, large trees; and (6) willow, large trees.

Segment 3: (1) cottonwood, large trees; (2) grassland; (3) willow/cottonwood, large trees; (4) willow / cottonwood/ash; and (5) willow, large trees.

Segment 4: (1) pasture; (2) grassland; (3) industrial; (4) embayments; (5) oak/Ponderosa pine; (6) residential; (7) oak; and (8) maple/Douglas fir.

Segment 5: (1) grassland; (2) rock/grassland; (3) rabbitbrush; (4) pasture; (5) rabbitbrush/grassland; (6) embayment; (7) herbaceous types; (8) agricultural production; and (9) shrub willow.

Segment 6: (1) rabbitbrush; (2) rabbitbrush/sagebrush; (3) field crops; (4) rock cliff/grassland; (5) grassland; (6) grassland/rabbitbrush; (7) sagebrush; and (8) bitterbrush.

In addition, 43 habitats in segment 4, 31 in segment 5 and 61 in segment 6 were identified immediately adjacent to the river shore. Approximately 75 percent of the total miles of shoreline in each of these segments consist of the following habitats listed in order of percent of total miles:

Segment 4: (1) rock rip-rap (34 percent); (2) grassland undifferentiated (11 percent); (3) willow, large trees (7 percent); (4) industrial (5 percent); (5) oak/Ponderosa pine (5 percent);(6) rock (5 percent); (7) willow, small trees (4 percent); and (8) oak (3 percent).

Segment 5: (1) rock rip-rap (40 percent); (2) gravel (14 percent); (3) rock (9 percent); (4) sand (8 percent); and (5) shrub willow (4 percent).

Segment 6: (1) sand (39 percent); (2) rock rip-rap (21 percent); and (3) gravel (12 percent).

From the habitats identified in the study area, and discussed above, 82 intensive sampling areas were established in 23 different habitats.

BIG GAME

Elk, mule deer, black-tailed deer, white-tailed deer, black bear, and cougar were found to occur within the study area. Black-tailed deer were the most widespread species being found in segments 1-5. Mule deer were recorded in segments 5 and 6. Elk and the endangered Columbian white-tailed deer were observed in segments 2 and 3. One observation of cougar (segment 4) and black bear (segment 2) were made during this study. Densities of all species of big game mammals were found to be low in the study area. All species of big game in the study area appeared to be permanent residents; no evidence was found that indicated any part of the study area was used as a "wintering area", or used only on a seasonal basis.

Black-tailed deer was the only species of big game mammal found to occur in segment 1. Although the total number of black-tailed deer present in this segment is probably very small, black-tails probably use all major vegetative types, but appeared to utilize beachgrass and alder most intensively.

Four species of big game mammals were recorded in segment 2. The Columbian white-tailed deer, observed most frequently on the Columbian White-tailed Deer National Wildlife Refuge (RM 34-39) is listed as an "endangered" species (U.S. Department of the Interior 1973). The Columbian white-tailed deer population of the lower Columbia River appeared to be approximately 375 individuals in 1975. Black-tailed deer were found throughout segment 2. Preferred habitat is upland forest. Riparian and upland edge habitats were used less by deer. Black-tailed deer were more abundant than white-tails in the segment except on the Columbian White-tailed Deer NWR. Elk and/or elk sign were observed only between RM 25-30 in pasture, Sitka spruce, and hemlock/Douglas fir/alder habitat. A maximum of 26 individuals were observed on only one occasion. Permanent residence of at least one black bear was noted in Sitka spruce habitat.

Columbian white-tailed deer, black-tailed deer, and elk were present in segment 3. One Columbian white-tailed deer was observed on Ridgefield NWR (RM 88) in grazed pasture near ash/cottonwood habitat.

Black-tailed deer were observed throughout the segment in riparian and upland vegetative types. Density of black-tails was low but appeared to be slightly higher than segment 2. Elk sign was noted at only one location near Rooster Rock State Park on the Oregon shore.

Black-tailed deer and cougar were the only species of big game mammals recorded in segment 4. One cougar was seen. Black-tailed deer or evidence of deer use were observed in most major types of habitat present in this segment. Black-tailed deer density was lower than segments 1-3.

Black-tailed deer, mule deer, and possible intergrades of these two subspecies were found in segment 5. The density of all deer appeared to be lower in this segment than all others. Deer use was restricted primarily

to canyon walls.

Mule deer was the only species of big game mammal observed to utilize segment 6. Evidence of limited deer use was noted in all vegetative types sampled. Most intensive use was in bitterbrush, cottonwood, willows, and marsh. Islands in this segment were used by mule deer as "fawning" areas. Deer use on islands was noted during all seasons but was greatest during spring and summer.

WATERFOWL

The inventory of waterfowl was conducted in the following three phases: (1) inventory of migrant waterfowl; (2) inventory of resident (breeding) waterfowl; and (3) an intensive appraisal of the status of Great Basin Canada geese on Umatilla NWR (segment 6).

Migrant Waterfowl

The study area receives its most intensive utilization by waterfowl during the fall and winter. Migrant waterfowl begin to arrive in the study area in mid-August. In addition to providing wintering habitat for several species of waterfowl, the study area also acts as a staging area for migrants. Lewis and Clark NWR (RM 19-35), Columbian White-tailed Deer NWR (RM 34-38), Ridgefield NWR (RM 88-93), Umatilla NWR (RM 262-281), and Sauvie Island WMA (RM 87-99) retain large numbers of waterfowl over the entire winter. In The Dalles and John Day Pools (segments 5 and 6, respectively) geese utilize the river for resting between feeding flights to nearby grain fields. We observed 27 species of waterfowl during the winter inventory. Included in species observed was: whistling swans; three species of geese, of which the Canada geese were the most important and numerous; nine species of dabbling ducks, with mallard, wigeon, and pintail providing the greatest numbers; six species of diving ducks; and eight other species including scoters, mergansers, grebes, and coot.

Baker Bay (RM 3-7) was the major concentration area in segment 1 for migrant waterfowl. Segment 1 received its greatest winter use during October when 4,020 American wigeon and 2,450 coots were observed in Baker Bay. Segment 1 was also one of the major wintering areas for canvasbacks, surf and white-winged scoters, and western grebes. This segment is not rich in waterfowl habitat, primarily because it is comprised of shipping channels, dredge-spoil islands, river sand deposits, and only a small amount of tidal marsh.

As many as 39,593 waterfowl were observed utilizing tidal marshes and islands of segment 2. Swans, Canada geese, mallards, wigeons, and pintails were the primary inhabitants. Waterfowl concentrated on Lewis and Clark NWR (RM 18-35) and Columbian White-tailed Deer NWR (RM 33-38). Tidal marshes of Lewis and Clark NWR provided resting and feeding habitat for wintering waterfowl. Whistling swans were observed almost exclusively in intertidal areas. Flooded pasture and agricultural lands on the Columbian White-tailed Deer NWR also provided substantial wintering habitat for waterfowl. The buildup of waterfowl in late winter indicates that segment 2 is also a staging area for waterfowl in prelude to spring migration north.

Over half of all waterfowl wintering on the study area (approximately 250,000 birds) were concentrated on Ridgefield NWR (RM 87-93) and Sauvie Island WMA (RM 87-99) in segment 3. Sturgeon Lake on Sauvie Island WMA, is the primary resting area in this segment. The agricultural land around the lake and on Ridgefield NWR provided food resources for the migrant waterfowl. The large influx of migrants into segment 3 began in October and

continued through December. Approximately 58,000 pintails, 55,000 wigeons, 35,000 mallards, and 13,000 Canada geese were estimated to use this segment during winter. Only a very small number of waterfowl utilized the river between Portland (RM 105) and Bonneville Dam (RM 142).

The maximum number of waterfowl observed in segment 4 during the winter inventory was 495 in January 1975; 250 were coots. Government Cove (RM 152) was used consistantly by coots throughout the winter. Small flocks of geese were observed along the Washington and Oregon shorelines. Other small flocks of waterfowl were noted infrequently in other portions of the segment.

As much as 82 percent of approximately 5,600 waterfowl in segment 5 were Canada geese. Miller Island (RM 203-207) and the gravel spits at RM 210-212 were the major resting areas for wintering geese, which began to arrive in October. Since The Dalles Pool has only a negligible amount of aquatic food resources, geese utilized wheat fields located within a few miles of the river to feed. Mallards and scaup were the most abundant ducks in the segment, with mallards being approximately four times as numerous.

In segment 6, the number of wintering waterfowl reached approximately 153,000 in February 1975. Of the 27 species of waterfowl known to winter in the study area, 23 were observed in this segment. Canada geese and mallards were the most numerous of the wintering species with as many as 71,513 and 75,783 counted, respectively. Canada geese began to arrive in October, peaked in January, and declined rapidly in March. Mallards were about 2 months later in their migration schedule. Umatilla NWR encompasses most of the potential wintering habitat for waterfowl in the impounded portion of the study area. Waterfowl wintering at Umatilla NWR incorporated up to 98 percent of the winter population for segment 6. Canada geese were observed in rafts along nearly the entire length of this segment, resting between feeding forays to wheat fields adjacent to the river. Mallards were observed concentrated along the Oregon shore at the western end of Umatilla NWR (RM 260-266). Long Walk islands, Long Walk Slough, and McCormack Slough (RM 273-276) retain most of the wintering population utilizing the refuge. Paterson Slough (RM 279-281) and Whitcomb Island (RM 266-268) were also concentration areas on Umatilla NWR.

Resident Waterfowl

The study area as a whole is not a major waterfowl producing area. Although the production of waterfowl is comparatively small, particularly in relation to the winter waterfowl population, 18 species of waterfowl were observed during the brood inventory and/or reported by the federal refuges as having nested within the study area. Canada geese and mallards were the most abundant and widely distributed species breeding in the study area. In 1974 and 1975, goose broods were found in all segments except segment 1 and mallards were observed in all but segment 4. Segment 6 had the highest production of geese and ducks. A total of 262 goose nests was located in segments 4-6 in 1975.

Two distinct waterfowl breeding habitats were recognized in the study area: the Columbia River estuary (RM 1-146); and the impounded reservoirs (RM 146-292). The estuary was affected by tidal fluctuation and the impounded segments were affected by pool level changes. Unstable water levels in conjunction with a very limited amount of non-tidal marsh were considered primarily responsible for the low density of breeding waterfowl in the study area. Most of the waterfowl breeding habitat present in the study area is Umatilla NWR. Tidal marshes of segments 1 and 2 and federal refuges in segments 2 and 3 provided additional limited areas for nesting waterfowl.

The Sand Islands (RM 4-6) and a small bay on the Oregon shore (RM 6-7) were the only brooding areas observed in segment 1. The western most Sand Island was grazed by cattle and had only "pockets" of marsh vegetation along its shore, while the Oregon bay had a lush growth of sedges, bentgrass, and arrowgrass. Thirteen mallard broods were observed in the bay and three were seen on the islands.

Mallards were the predominant species observed with broods in segment 2. Wood duck, green-winged teal, blue-winged/cinnamon teal, and common merganser broods were noted in this segment also. Most duck brooding habitat was located on Lewis and Clark NWR and the adjacent Columbian White-tailed Deer NWR. Most broods observed on Lewis and Clark NWR were near tidal marshes associated with upland habitat. Gray's Bay (RM 18-23) was utilized as a brooding area for near-fledgling mergansers. Dibblee Island (RM 62-64) was the only place that brooding geese were noted in segment 2; six broods were observed there in 1975. The two NWR's reported in their annual waterfowl production reports that eight species of waterfowl nested within their respective boundaries, producing a total of 611 young in 1975.

Twenty-three Canada geese, six mallard, and one wood duck broods were seen during the brood survey flights made in 1975 in segment 3. Although Sauvie Island WMA had the largest concentration of waterfowl in the winter, there were no broods of waterfowl there during either 1974 or 1975. Nine species of waterfowl produce approximately 500 young on Ridgefield NWR, according to refuge waterfowl production reports. Mallard, pintail, and blue-winged/cinnamon teal are the most prolific species on the refuge. Intensive agricultural practices, primarily grazing, has diminished the potential waterfowl breeding habitat in the areas surrounding and including Ridgefield NWR and Sauvie Island WMA. Of the 23 goose broods observed in segment 3, all but three were seen in the eastern half of the segment. A creche of six broods was observed near the eastern end of Government Island (RM 116); eight broods were on the Washington shoreline adjacent to Arthur Lake (RM 138-139); and six broods were seen on Pierce Island (RM 142).

During the nest and brood survey in 1975, 69 goose nests were found on islands in segment 4; 49 of these nests were considered successful. The 23 goose broods observed in Government Cove (RM 153) in 1975 consisted of 97 goslings and 47 adult geese, while the 21 broods observed there in 1974 were made up of 99 goslings and 44 adult geese. The only other resident waterfowl observed in segment 4 were a common merganser brood at the mouth

of the Little White Salmon River (RM 163) in both 1974 and 1975 and a wood duck brood seen at Stanley Rock (RM 171) in 1974. Thirty-six goose nests were found on islands between Bonneville Dam (RM 146) and RM 156. Viento Island (RM 160) had nine nests in 1975, and Well's Island (RM 167) had six goose nests. Bonneville Pool provides some of the more unique nesting habitat utilized by Canada geese on the study area. The vegetative cover on islands used for nesting varied from those virtually void of vegetation to some that were grown to dense alder and Douglas fir. Most islands used for nesting were covered with a matting of low grasses and forbes.

Waterfowl production in segment 5 was lower than in segments 4 and 6. Only 20 goose nests were found in this segment during the 1974 and 1975 nest inventories. Only three mallard nests were found in 1975. In 1975, 14 of the goose nests were considered successful. Nine of the successful nests were located on Little Miller Island (RM 203), which is less than 1 acre in size. In addition, two of the three mallard nests found in this segment in 1975 were on Little Miller Island. Brown's Island (RM 197-198) was also used by geese and mallards for nesting; three goose nests, one mallard nest, and three mallard broods were observed there in 1975. Willow and horsetail were the primary plant species associated with waterfowl nests in segment 5. Deschutes River State Park (RM 205) and Horsethief Lake State Park provided the primary brooding habitat for ducks and geese in segment 5.

Segment 6 is the major production area for the entire study area. In 1974 and 1975, 175 and 166 Canada goose nests were found in segment 6. Umatilla NWR personnel estimated the annual production of 14 species of ducks to be approximately 2,000. Although the first 34 miles of segment 6 is virtually void of waterfowl nesting habitat, the remaining 42 miles incorporates nesting islands, large sloughs, and marshland that provide waterfowl breeding habitat. McCreadie Islands (RM 254-255), Three-mile Canyon Island (RM 255), and islands on Umatilla NWR (RM 273-276) provided most of the goose nesting habitat available in segment 6. Goose nests were found associated primarily with sage/cheatgrass communities on these islands. In 1975, goose broods were observed at Paterson Slough (RM 279-281), McCormack Slough (RM 275), Whitcomb Island (RM 265-269), Long Walk Slough (RM 274-277), and Willow Creek WMA (RM 253). Waterfowl production, other than Canada geese, in segment 6 is restricted almost entirely to Umatilla NWR and adjacent management areas. McCormack Slough, Paterson Slough, and Irrigon WMA (RM 282-288) provided most of the duck nesting habitat. Goose nesting islands on Umatilla NWR were also used by mallards and wigeon as nesting and brooding sites. Mallards, pintails, shovelers, cinnamon teal, wigeons, and wood ducks were observed either nesting or brooding in this portion of segment 6. Common merganser broods were seen in the John Day River arm of segment 6 (RM 218) during 1974 and 1975.

AQUATIC FURBEARERS

All species classified as aquatic furbearers in this study (i.e., beaver, river otter, mink, muskrats, and nutria) were found to occur within the study area.

All species classified as aquatic furbearers were present in segment 1. Five-seven beaver colonies were found in non-tidal freshwater habitat in this segment in fall of 1974. Otter sign was noted at only one location on the Washington shore in tidal marsh. Mink were recorded only in tidal marsh and beachgrass adjacent to tidal marsh but probably occur at low densities in most habitats in segment 1. Quantitative data from trapping indicate that muskrats were most abundant in tidal marsh and nutria were most abundant in non-tidal, freshwater, willow/alder swamps. Muskrats were more numerous than nutria in tidal marsh and spruce/alder swamp but nutria was the more numerous of the two species in non-tidal willow/alder swamp.

All species of aquatic furbearers were recorded in segment 2. Most species were found to occur in most types of habitat associated with water in almost all portions of this segment. In addition, relative abundance of aquatic furbearers as a group and muskrats, nutria, and beaver specifically was higher in this segment of the study area than in all others. The presence of beaver was noted throughout the segment but beaver use was most intense in sloughs, ponds, and other areas protected from tidal action. The reported harvest of beaver in this segment was 375 animals in 1973-74 and 409 in the 1974-75 trapping seasons. Otter were found to be uncommon. Mink likely occur throughout segment 2, but at low densities. Nutria were much more abundant than muskrats in tidal marsh, tidal willow, and tidal Sitka spruce habitats and are probably more abundant throughout the segment.

All species defined as aquatic furbearers in this study were found to occur in segment 3. Density of aquatic furbearers as a group was lower than that of segment 2 but higher than other segments of the study area. Beaver were found throughout the segment but primarily in areas protected from water fluctuation and wave action. The reported harvest of beaver was considerably lower than in segment 2; 90 in 1973-74 and 55 in 1974-75 trapping seasons. Otter were found to be more abundant in this segment than all others especially between RM 125 and 133. Mink, muskrat, and nutria densities were low in segment 3. Nutria density was highest in the downstream portion of the segment.

All species of aquatic furbearers except nutria were found to occur in segment 4. Density of aquatic furbearers as a group appeared to be lower in this segment than in segments 1-3, but higher than that of segments 5 and 6. Evidence of beaver use in recent years was observed in essentially all areas supporting stands of riparian trees or shrubs. Beaver use was again confined primarily to "protected" areas which included embayments, ponds, and sloughs in this segment. Twenty-three "colonies" of beaver (70-100 individuals) were estimated for this segment in fall 1974. Otter probably occur throughout the segment in low numbers. Based on the number of

observations of sign, mink are more abundant in segment 4 than all other segments. Rip-rap appeared to be used consistantly by mink especially in areas adjacent to embayments. Muskrats occur throughout the segment in riparian plant communities containing grasses, sedges, and/or rushes. Muskrats utilized embayments and sloughs primarily.

Beaver, otter, mink, and muskrats were present in segment 5 during the study. Densities of aquatic furbearers were very low in this segment, lower than all other segments. Very little riparian vegetation was present to support beaver, muskrat, and mink populations. Seven "colonies" of beaver were found and approximately 20-30 beaver are estimated to have been present in the segment in fall 1974. The presence of otter was documented by observations of road kills, tracks, and direct observation of otter. Otter utilizing this segment of the study area appeared to be associated with the Deschutes River also. The density of mink and muskrats appeared to be very low in this segment.

Density of beaver, otter, mink, and muskrats as a group is very low in segment 6. Almost no riparian habitat suitable for beaver, mink, and muskrats existed in the downstream 60 percent (RM 216-263) of the segment. Observations of the above mentioned species and otter made in this portion of the segment were invariably associated with tributary streams. Most aquatic furbearers found in this segment occurred from RM 263 upstream. It was this portion of the segment that contained almost all suitable habitat. Approximately 14-15 colonies of beaver were estimated to be present in the segment, primarily in areas supporting riparian trees and shrubs especially young cottonwood. Otter appeared to be common in this segment during the study, with a density only slightly less than that of segment 3. Few mink occurred in this portion of the study area and muskrat densities as a whole were low. Moderate densities of muskrats were present in marshes upstream from RM 265.

TERRESTRIAL FURBEARERS

Species of mammals inventoried as terrestrial furbearers and found to occur in the study area include opossum, porcupine, red fox, gray fox, coyote, raccoon, badger, striped skunk, spotted skunk and bobcat. Raccoons and coyotes were the most widely distributed terrestrial furbearers in that they were found to occur in all segments of the study area. Striped skunks were identified in all segments except segment 1. Red fox had the most restricted occurrence in the study area being found to occur only in segment 3. All species found to occur in the study area appeared to be present during all seasons. In addition, all species found to occur in the study area appeared to be present on both Oregon and Washington shores and probably on many of the larger islands.

Raccoons, coyotes and gray fox were the only terrestrial furbearers identified in segment 1. Opossums, bobcats, porcupines, and striped and spotted skunks are also expected to occur in this segment. Raccoons were probably the most abundant terrestrial furbearer in segment 1; the greatest amount of sign was found in alder habitat. Coyotes and gray fox probably utilize most types of habitat in segment 1, however, the density of both species appears to be low. Of the habitats sampled, alder and tidal marsh appear to be important habitats for terrestrial furbearers in this segment.

Opossums, raccoons, coyotes, striped skunks, spotted skunks, gray fox, and porcupines were recorded in segment 2. Raccoon was also the most abundant terrestrial furbearer in this segment, its density exceeding that of segment 1. This species was more abundant in intertidal habitat, being most abundant in tidal marsh habitat. Opossums occurred throughout segment 2; however, their density was lower in intertidal areas than non-tidal areas. Densities of striped skunks, coyotes, gray fox, spotted skunks, and porcupines appeared to be low in this segment but greater than segment 1.

Terrestrial furbearers found to occur in segment 3 included opossums, raccoons, coyotes, bobcats, red fox, gray fox, and striped skunks. Coyote sign was observed more than any other species of terrestrial furbearer, especially in riparian habitat. Opossums and raccoons were the next most widely distributed terrestrial furbearers; riparian vegetative types were preferred. The most abundant terrestrial furbearer in this segment was the opossum. Density of opossums appeared to be higher in segment 3 than all other segments of the study area. Highest densities of opossums occurred in cottonwood habitat. Raccoon was the next most abundant terrestrial furbearer, occurring in higher densities than segment 1 but lower densities than in segment 2. Based on total number of observations, coyotes were more abundant than red fox and red fox were more abundant than striped skunk in this segment.

Terrestrial furbearers that occurred in segment 4 included the opossum, porcupine, raccoon, coyote, bobcat, striped skunk, and spotted skunk. Raccoons probably occur in most major vegetative types, preferring riparian habitats, and were the only terrestrial furbearers found to utilize rock rip-rap that forms approximately 50 miles of shoreline in this segment.

Striped skunks, coyotes, bobcats, and porcupines appeared to be distributed throughout the segment. The raccoon is probably the most abundant terrestrial furbearer in segment 4. The striped skunk was next most abundant and coyotes were the third most abundant terrestrial furbearer. Oak/Ponderosa pine and shrub willow are possibly the most important habitats in this segment because they support the highest terrestrial furbearer diversity.

Terrestrial furbearers recorded in segment 5 included coyotes, striped skunks, bobcats, raccoons, spotted skunks, porcupines, and badgers. As in segment 4, raccoons were the only terrestrial furbearer found to utilize rock rip-rap that occurs along 30.4 miles of shoreline in segment 5. Coyotes, bobcats, and porcupines appeared to be distributed throughout the segment. Spotted skunks were noted in rabbitbrush, rock cliff/grassland and grassland habitats. One supplemental observation of a road-killed badger was made near rabbitbrush habitat. The striped skunk was the most abundant terrestrial furbearer in segment 5, especially in rock cliff/grassland and grassland habitats. Raccoons were next in abundance, being most abundant in willow habitat. Coyotes and bobcats appeared to be less abundant than striped skunks and raccoons. Bobcats occur in greater densities in segment 5 than in segments 1-4.

Opossums, porcupines, coyotes, bobcats, raccoons, badgers, striped skunks, and spotted skunks were found to occur in segment 6. Coyotes and/or their sign were observed in most habitats. Most observations of the presence of badgers were made in the eastern portion of segment 6 (RM 248-288). Sagebrush and rock cliff/grassland appeared to be preferred habitats of bobcats. Striped skunks and porcupines were distributed throughout the segment. Coyotes appeared to be the most abundant terrestrial furbearer in segment 6. Raccoons were the next most abundant, occurring most abundantly in riparian habitats.

BIRDS OTHER THAN WATERFOWL

Two hundred and two (197 non-anseriforme) species representing 16 orders and 51 families were seen in the study area. The varied vegetative types present provided cover in which large numbers of birds were found throughout the year. An estimated total of 363,838, 172,127, 366,127 and 289,357 birds utilized selected vegetative types in the study area during the fall, winter, spring and summer, respectively. Number of birds actually occurring in the study area is undoubtedly much larger than the numbers given above. The study area undoubtedly furnishes habitat for a significant percentage of the total population of yellow warblers, long-billed curlews, and Bewick's wrens in Oregon and Washington. All of these species are having problems elsewhere in their range.

Some of the riparian habitats sampled had the highest densities ever recorded for bird communities (Udvardy 1957, Wiens 1973). Ten of the areas censused had 1,000 or more birds per 100 acres during the breeding season, and four of these had densities which exceeded 1,500 birds per 100 acres. Densities during the non-breeding season were frequently higher than those observed during breeding season.

A number of unique areas were identified in the study area. These are listed below:

1) Birds rookeries: -- A number of these were located during this study. One of the largest located and the one containing the greatest number of species was the gull and tern colony at Threemile Canyon in segment 6. The closeness of this colony to the mainland and its suitability for other uses, makes it the most vulnerable to disturbances resulting in decreased reproductive success and possible abandonment of the colony.

2) Riparian Vegetation: -- The stands of cottonwood (pure and stands mixed with other species) located along the Columbia River represents a unique bird habitat and one of the richest in terms of numbers of birds and species (Bottorff 1974, Gaines 1974, this paper). While the total cottonwood acreage in Washington and Oregon is not known, that occurring in the study area probably represents a significant percentage of the total. The Sitka spruce stands in segment 2 are also very rich in bird species and number of birds.

Game Birds

Ruffed grouse, chukar, Hungarian partridge, ring-necked pheasant, California quail, turkey, mourning dove, band-tailed pigeon and common snipe were found to occur within the study area.

Ruffed grouse, ring-necked pheasant, snipe, and band-tailed pigeons were observed in segment 1. Game birds populations in this segment appeared to be generally low with the exception of snipe in tidal marsh during fall and winter and wet areas in stands of beachgrass in spring.

In segment 2, ruffed grouse, ring-necked pheasants, California quail, mourning doves, band-tailed pigeons, and snipe were found to occur. As in segment 1, gamebirds are not abundant in this segment except for snipe in tidal marsh during fall. Relative to segment 1, however, this segment has more species and higher densities of game birds.

Ruffed grouse, ring-necked pheasants, California quail, mourning doves, and band-tailed pigeons were recorded in segment 3. California quail are probably the most abundant and widespread game bird in this segment. In a few locations, band-tailed pigeons are fairly numerous. Ring-necked pheasants were found near agricultural crops in most portions of the segment at low densities and on Sauvie Island at slightly higher densities.

Game birds recorded in segment 4 included ruffed grouse, mourning dove, band-tailed pigeon, and snipe. Oak, oak/pine, and large willow are important habitats for most species of game birds in this segment. The most widespread and abundant species appear to be California quail and mourning doves. Grouse, pheasants, turkeys, band-tails, and snipe were observed infrequently. Turkeys or evidence of their presence were observed at only three locations (RM 179-183) in large willow and grassland habitat.

Game birds recorded for segment 5 included the ring-necked pheasant, California quail, chukar, mourning dove, and snipe. The chukar was the most abundant and widespread species observed in this segment. Pheasant and quail occurred in low to moderate numbers, and appeared to be most numerous in riparian habitats of the Oregon shore between RM 203 and RM 212. Chukar density appeared to be highest on the Washington shore between RM 204 and 208. All species except chukar were found to utilize riparian habitat.

Ring-necked pheasants, California quail, chukars, mourning doves, and snipe were observed in segment 6. Pheasants and quail were found throughout the segment, but were most abundant upstream from RM 264. Chukar were observed only downstream from RM 263 on the Washington shore and RM 245 on the Oregon shore. Chukars appeared to be associated with canyon walls in the study area. The largest numbers of chukars were observed between Blalock Canyon (RM 233) and John Day Dam (RM 215.6) on the Oregon shore and between Rock Creek (RM 228) and the dam on the Washington shore. All species except chukar were observed to use riparian habitat.

Colonial Nesting Species

Twelve colonial nesting species were found nesting in the study area. A small group of double-crested cormorants was found nesting on snags in the river on Umatilla National Wildlife Refuge. An undetermined number of pelagic cormorants nest in the seaward facing cliff face at Cape Disappointment, Washington. Nine great blue heron rookeries,

ranging in size from 3 to 555 pairs of birds, are known to occur in the study area (segments 2, 3, 4, and 6). Two nesting colonies (10-12 pairs, estimated) of black-crowned night herons were located in segment 6. Glaucous-winged gulls were found nesting on two islands in segment 5 near Biggs, Oregon, and on Sand Island near Ilwaco, Washington, in segment 1. The colonies near Biggs represent the only inland nesting record for this species and constitutes a major range extension from previously known breeding localities. The largest colony of glaucous-winged gulls was found on Sand Island in segment 1 (360-520 pairs, estimated). Western gulls nest on Cape Disappointment (number of pairs, uncertain) and Sand Island (540-780 pairs) in segment 1. California gulls were found nesting at two locations in segment 5 (275, 213 nests estimated) and at Threemile Canyon (RM 256) in segment 6 (500 pairs estimated). Ring-billed gulls were found nesting at one location in segment 5 (6 pairs counted) and at one location in segment 6 (500 pairs estimated). A colony of at least 100 pairs of Forster's terns was located on the island immediately offshore at Threemile Canyon, segment 6. A colony of Caspian terns was also located at Threemile Canyon in segment 6 and contained at least 169 pairs. Observations of adults near Sand Island suggested that Caspian terns may also nest in small numbers in segment 1. Fifty-one occupied nest burrows of bank swallows were counted in an abandoned gravel pile on Umatilla NWR in segment 6. Cliff swallows were the most abundant swallow seen and were found throughout the study area during the breeding season. This species was especially abundant in the eastern half of segment 4 and in segments 5 and 6. Colonies of up to several hundred pairs were seen on cliff faces and bridges.

Birds of Endangered, Threatened, Peripheral, or Undetermined Status

Thirty-four of 202 (16.7 percent) species observed in this study are listed by U. S. Department of the Interior (1973), Marshall (1969), or Arbib (1973) as being species whose status is at least uncertain or threatened in part of their ranges.

This list includes the red-throated loon, red-necked grebe, horned grebe, western grebe, common egret, double-crested cormorant, black-crowned night heron, sharp-shinned hawk, Cooper's hawk, Swainson's hawk, marsh hawk, bald eagle, osprey, prairie falcon, peregrine falcon, American kestrel, sandhill crane, snowy plover, long-billed curlew, short-billed dowitcher, Caspian tern, yellow-billed cuckoo, barn owl, burrowing owl, purple martin, Bewick's wren, water pipit, loggerhead shrike, Hutton's vireo, yellow warbler, common yellowthroat, pine grosbeak, gray-crowned rosy finch, black rosy finch, and fox sparrow.

Raptors

Twenty-two species of raptors were observed in the study area. One additional species was observed adjacent to the study area and two others are known to have occurred in the area in recent years. Raptors found in the study area include the goshawk, sharp-shinned hawk, red-tailed hawk, Swainson's hawk, rough-legged hawk, golden eagle, bald eagle, marsh hawk,

osprey, gyrfalcon, prairie falcon, peregrine falcon, merlin, American kestrel, barn owl, screech owl, great horned owl, snowy owl, pygmy owl, burrowing owl, long-eared owl, short-eared owl, saw-whet owl, hawk owl and northern shrike. This total represents 69 percent of the raptors known to occur in Washington and Oregon (Bertrand and Scott 1973, Larrison and Sonnenberg 1968).

Raptors were found in all segments of the study area at all times of the year. They were found in habitats ranging from open beaches to mature closed-canopy stands of cottonwood. The greatest number of species (8) in a single habitat was found in sampling area 9, segment 6 (Russian olive). At least three of these species (long-eared owl, screech owl, and barn owl) were known to nest in the Russian olive stand. The fact that Russian olive is one of the few vegetative types in the area suitable for nest sites probably explains the high diversity and density of raptors there. The next highest number of raptor species (4 and 5) was found in stands of cottonwood. Beachgrass in segment 1, ash/willow/cottonwood in segment 3, and grassland in segment 6 each had four species of raptors. All other habitats sampled had three or fewer species. The red-tailed hawk was the most widespread of the raptors being found in 25 of the areas surveyed. The marsh hawk was found in 14 areas; and American kestrels were observed in 12 areas. The most widespread owl was the screech owl, being found in nine areas. The great horned owl and saw-whet owl occurred in six areas.

Avifauna of Study Area

A total of 98 species of birds were seen in segment 1 of the study area. Twelve additional species are known to occur in the segment. In addition, almost every species of marine bird known to occur in Oregon and Washington could probably be seen off either the north or south jetty, with weekly observations from April to September. Sixteen of 41 summer residents in this segment were also present in winter. Alder was the most productive habitat in terms of number of species seen, as well as density and biomass. The fall density of 4,763 birds per 100 acres in this habitat was one of the highest observed during the study.

Eighty-nine species of birds were seen in segment 2. Fifteen of 42 summer residents (35.7 percent) were also present in winter. The greatest number of species in this segment was found in Sitka spruce habitat in all seasons except spring when cottonwood had the largest number. Sitka spruce had the highest bird densities in fall and winter, cottonwood/willow in spring, and cottonwood in summer. Productivity of habitats (bird biomass) varied seasonally with no single habitat having the highest values during all four seasons. Estimates of the total number of birds occurring in tidal marsh, tidal shrub willow, large willow, cottonwood/willow, Sitka spruce and cottonwood are quite high and greater than that for similar habitat in other segments during all seasons except spring. The most abundant birds in the above vegetative types during fall and winter were the black-capped chickadee, golden-crowned kinglet, song sparrow, and winter wren. The tree swallow was the most abundant

species in spring and Swainson's thrush in summer.

A total of 104 species of birds were seen in segment 3. An additional 35 species have been recorded on the Sauvie Island Christmas Bird Counts conducted in this segment. Fifteen of 42 summer residents were also present during winter. Of the eight types of habitat inventoried, cottonwood had the greatest number of species in all seasons except spring, and had the highest densities in spring and summer. Large willow had the highest density of birds in fall and winter (3,264 and 2,767 birds/100 acres, respectively). This high density reflects the large, mixed-species flocks of downy woodpeckers, black-capped chickadees, golden-crowned kinglets and dark-eyed juncos that were found there.

Ninety-four species of birds were seen in segment 4. Twenty of 60 species of birds (33 percent) found during summer were also found during the winter survey. Of the 10 types of habitat sampled in this segment, oak/pine had the greatest number of species overall (44) as well as in each season except winter. Habitat containing the greatest bird biomass was large willow.

A total of 69 species of birds were seen in segment 5. Eight of 21 summer residents (38 percent) were also found in winter. Large willow had the greatest number of species as well as the highest densities of birds of the habitats sampled. Total number of birds utilizing large willow, shrub willow, open water, rip-rap, and rabbitbrush habitats were lower in this segment than in similar habitats in segments 2, 3, and 4. Of the habitats censused, the greatest number of birds used rip-rap during fall and winter. Most unique about this segment was the large numbers of gulls nesting on islands, and species associated with cliffs.

Ninety-four species of birds were observed in segment 6. Thirty-four additional species are listed as occurring in Umatilla NWR (U.S. Fish and Wildlife Service 1973). Ten of 36 summer residents (27.8 percent) were also present in winter. Of eight types of habitat sampled in this segment, Russian olive had the greatest number of species in all seasons and the highest density of birds in fall and winter. Cottonwood/willow habitat had the highest densities during spring and summer. The 44 species of birds found in the Russian olive sampling area was as great as that found anywhere else in the study area. The greatest number of birds utilized Russian olive in fall, cottonwood/willow in summer, and rabbitbrush in winter and spring. The number of birds utilizing rip-rap and water within 100 meters of the shoreline was small.

SMALL MAMMALS

Thirty-nine species of small mammals were identified in the study area. All species were associated with intensive sampling areas except the mountain beaver, gray squirrel, and gray-tailed vole which were identified in areas other than those chosen for intensive sampling. Sixteen additional species were not identified during the study but may possibly occur in or near the study area. Many of these species do not occur at low elevations and/or are rare.

Segment 1

Eighteen species of small mammals were recorded in segment 1. Insectivores were predominant in habitats sampled in this segment. The vagrant shrew, dusky shrew, shrew-mole, and deer mouse occurred in all habitats sampled. Of the habitats sampled, alder was occupied by the greatest number of species and is probably the most important habitat in this segment for small mammals.

Sixteen species were recorded in the fall sampling period. The overall average estimate of abundance of all small mammals captured during fall was 1.45 captures/100 trap-nights. Average estimates of relative abundance for small mammals ranged from 0.13 to 9.68 captures/100 trap-nights. The coast mole had the lowest average estimate of abundance recorded, while the vagrant shrew had the highest average estimate. The creeping vole and deer mouse were considered moderately abundant.

Seventeen species were recorded during the spring sampling period. The overall average estimate of abundance of all small mammals captured during spring was 2.13 captures/100 trap-nights. Average estimates of relative abundance for small mammals ranged from 0.12 to 9.52 captures/100 trap-nights. The lowest average estimate of abundance was recorded for the Pacific jumping mouse. The vagrant shrew had the highest average estimate of abundance. The deer mouse and creeping vole were moderately abundant during spring.

Segment 2

Nineteen species of small mammals were identified in segment 2. Tidal Sitka spruce, cottonwood, and cottonwood/willow habitats had the highest diversity of small mammal species in this segment. Tidal shrub willow had the lowest species diversity. Both the vagrant shrew and deer mouse occurred in all habitats sampled in segment 2 and were the most abundant species in this segment. Reed canarygrass and tidal marsh habitats supported the highest numbers of vagrant shrews. Deer mice were most abundant in tidal Sitka spruce, large willow, and cottonwood/willow habitats.

Sixteen species were recorded during the fall sampling period. The overall average estimate of abundance of all small mammals captured during fall was 1.40 captures/100 trap-nights and ranged from 0.05 to 5.85

captures/100 trap-nights. Townsend's mole had the lowest average estimate of abundance, and the deer mouse had the highest average estimate in fall. The vagrant shrew was also considered abundant.

Seventeen species were recorded during the spring sampling period. The overall average estimate of abundance for all small mammals captured in spring was 2.65 captures/100 trap-nights and ranged from 0.10 to 7.77 captures/100 trap-nights. The species with the lowest average estimate was the creeping vole. The highest average estimate was recorded for the deer mouse. The vagrant shrew was also abundant during the spring.

Segment 3

Sixteen species of small mammals were recorded in segment 3. Ash/willow/cottonwood habitat had the highest diversity of small mammals in this segment. All habitats sampled supported populations of the three most abundant small mammal species in segment 3. These species in order of abundance are the deer mouse, vagrant shrew, and Townsend's vole. The greatest number of deer mice was recorded in cottonwood/willow habitat, while reed canarygrass supported the greatest number of vagrant shrews and Townsend's voles.

During the fall sampling period, 12 species of small mammals were recorded. The overall average estimate of abundance of all small mammals captured during fall was 2.79 captures/100 trap-nights. Average estimates of relative abundance for small mammal species ranged from 0.05 to 13.10 captures/100 trap-nights. The lowest average estimate of abundance was recorded for the shrew-mole, and the deer mouse had the highest average estimate in fall.

Eleven species were recorded during the spring sampling period. The overall average estimate of abundance for all small mammals captured in spring was 3.68 captures/100 trap-nights. Average estimates of relative abundance for small mammal species ranged from 0.10 to 12.19 captures/100 trap-nights. The dusky shrew had the lowest average estimate of abundance in spring. The deer mouse had the highest average estimate. Vagrant shrews were also abundant during the spring.

Segment 4

Small mammal species diversity was highest in this segment. Strong habitat selectivity was apparent with 14 of the 20 species recorded in three types of habitat or less. The deer mouse was the only species in segment 4 that occurred in all types of habitat sampled and was the most abundant small mammal in each habitat sampled except large willow where the long-tailed vole was most abundant. Rock rip-rap habitat supported the highest numbers of deer mice in this segment. The long-tailed vole was more widely distributed and more abundant in this segment than segments 1-3. Willow and Douglas fir/maple habitats were occupied by the greatest number of species of small mammals and are probably the most important habitats for small mammals in segment 4.

During the fall sampling period, 17 species were recorded. The overall average estimate of abundance of all small mammals captured during fall was 1.36 captures/100 trap-nights. Average estimates of relative abundance for small mammal species ranged from 0.08 to 10.89 captures/100 trap-nights. Both the California ground squirrel and Northern flying squirrel had the lowest average estimate of abundance. The highest average estimate during fall was recorded for the deer mouse.

Sixteen species were recorded during the spring sampling period. Overall average estimate of abundance of all small mammals captured during spring was 2.08 captures/100 trap-nights. Average estimates of relative abundance for small mammal species ranged from 0.21 to 14.79 captures/100 trap-nights. The lowest estimate of abundance was recorded for the Northern pocket gopher. The deer mouse had the highest estimate in spring. Long-tailed voles were moderately abundant during spring.

Segment 5

Species diversity of small mammals was lowest in segment 5. Only nine species were recorded. Deer mice were captured in all habitats sampled and were the most abundant small mammal in each. As in segment 4, rock rip-rap habitat also supported the highest number of deer mice of all habitats. The deer mouse made up 97 and 91 percent of the total small mammal catch in the fall and spring sampling seasons, respectively. The presence of Nuttall's cottontail also was noted in all types of habitats sampled in the segment. Rabbitbrush, rockcliff/grassland and rock rip-rap are important small mammal habitats in segment 5.

All nine species of small mammals were recorded during the fall sampling period. The overall average estimate of abundance of all small mammals captured during fall was 6.82 captures/100 trap-nights. Average estimates of relative abundance for small mammal species ranged from 0.15 to 26.44 captures/100 trap-nights. The Western harvest mouse had the lowest estimate of abundance in fall, while the highest estimate was recorded for the deer mouse.

Seven species were recorded during the spring sampling period. The overall average estimate of abundance of all small mammals captured during spring was 8.03 captures/100 trap-nights. Average estimates of relative abundance for small mammal species ranged from 0.40 to 22.92 captures/100 trap-nights. The lowest estimate of abundance was recorded for the Great Basin pocket mouse. The deer mouse had the highest estimate in spring.

Segment 6

Seventeen species of small mammals were identified in segment 6. Nuttall's cottontail was found in all habitats sampled. Russian olive habitat appeared to support the greatest number of this species and was the only habitat where the deer mouse was not recorded. Rock rip-rap, talus, and rockcliff/grassland were habitats in which the deer mouse

was most abundant. Ord's kangaroo rat was found only on the Oregon shore and islands, while the white-tailed jack rabbit and Northern grasshopper mouse were found only on the Washington shore. Rabbitbrush habitat had the highest small mammal diversity in segment 6.

Fourteen species were recorded during the fall sampling period. The overall average estimate of abundance of all small mammals captured during fall was 1.43 captures/100 trap-nights. Average estimates of relative abundance for small mammal species ranged from 0.06 to 11.12 captures/100 trap-nights. Nuttall's cottontail had the lowest estimate of abundance in fall. The highest estimate was recorded for the deer mouse.

During the spring sampling period 16 species were recorded in segment 6. The overall average estimate of abundance for all small mammals captured during fall was 1.78 captures/100 trap-nights. Average estimates of relative abundance for small mammal species ranged from 0.07 to 10.22 captures/100 trap-nights. The lowest estimate of abundance was recorded for the Northern grasshopper mouse. The deer mouse had the highest estimate in spring.

MARINE MAMMALS

The harbor seal was the only species of marine mammal found within the study area during this study. We observed harbor seals only in segment 2, but they must at least pass through segment 1 to reach segment 2. Pearson (1969) identified a harbor seal "haulout" at Desdemona Sands (RM 9) in segment 1. We observed seals on five occasions between RM 22 and RM 25. In addition, D. McKay (Personal communication) observed one harbor seal on each of three occasions in March, April and May 1975 at Miller Sands (RM 24). These observations and those made during this study were made at or near sites Pearson (1969) identified as harbor seal haulouts located at Taylor Sands, Channel Sands, Grays Bay, Green Island, Seal Island, and the ship channel east of Miller Sands. According to our observations, the Columbia River was not utilized to any major extent by marine mammals during this study.

BATS

Bat populations were inventoried in 41 intensive sampling areas in the study area; bats were observed in 24 of these areas. The occurrence of most species observed appeared to be dependent upon (1) presence of insect (prey) populations, (2) presence of adequate day and night roosts, (3) streams, embayments, ponds and other bodies of water near foraging and/or roosting areas, and (4) protection from wind while foraging.

In segment 1, bats were observed only in alder habitat, of six habitats sampled. No species were identified.

Seven habitats were sampled for bats in segment 2. Bats were found in all habitats except tidal marsh. The big brown bat, long-legged myotis, Yuma myotis, and Townsend's big-eared bat were collected from roosts, the little brown myotis and big brown bat were identified in three of the habitats sampled. Of these two species identified, the little brown myotis was found in more habitats and was more abundant than the big brown bat.

In segment 3, bats were observed in five of seven habitats sampled. Three species were identified in three of the habitats in which bats were observed. The little brown myotis was most abundant, the Yuma myotis was second in abundance, and the big brown bat was least abundant in these habitats in this segment. Of the five habitats in which bats were observed, they appeared to be most abundant in ash.

In segment 4, bats were found in five of eight habitats sampled. Ten species were identified in three of the five habitats in which bats were observed. Of these species, the little brown myotis was found in the greatest number of habitats and was the most abundant. The big brown bat was second in abundance and the eight other species were approximately equally abundant. Within the five habitats in which bats were found, the greatest numbers were observed in oak/pine; large willow, embayment; and Douglas fir/maple habitats. Of these, oak/pine was the most diverse, with 10 species identified.

In segment 5, bats were found in three of five habitats sampled. The small-footed myotis, western pipistrelle, big brown bat, and pallid bat were observed in rock cliff/grassland habitat. The pallid bat was found in rip-rap habitat. Within these habitats, the greatest numbers of bats were observed in rock cliff/grassland.

In segment 6, bats were observed in three of nine habitats sampled. The small-footed myotis, little brown myotis, big brown bat, and pallid bat were identified in two of the three habitats in which bats were observed. As in segment 5, all four species appeared to be equally abundant in this segment. The greatest numbers of bats were also observed in rock cliff/grassland habitat and of the two species identified there, the small-footed myotis was probably more abundant than the big brown bat.

REPTILES AND AMPHIBIANS

Fifteen species of amphibians and 16 species of reptiles were identified in the study area. These represent approximately 74 percent of the species potentially occurring there according to the range maps of Stebbins (1954 and 1966). Thirteen amphibian and 14 reptile species were associated with intensive sampling areas. Four species, the Pacific giant salamander, Larch Mountain salamander, pigmy horned lizard, and the rubber boa, were identified from areas other than those chosen for intensive sampling. Published records from available literature indicate that seven additional species of amphibians and four species of reptiles occur within the limits of the study area, or have in the past. Four species of amphibians and one species of reptile found on the study area have been considered of undetermined or potentially threatened status in some part of their range.

The majority of species found in the habitats censused in segment 1 were on the Washington shore. Beachgrass habitat supported few species, and low densities of reptiles and amphibians. Tidal marshes were also not extensively utilized. Species found in this habitat could be attributed to 'edge' habitat. Alder was found to be occupied by the majority of the species encountered and is likely to be the most important habitat for those species in this segment. The most common amphibians appear to be the Pacific treefrog and the Northern red-legged frog. Common reptiles are the the red-spotted garter snake and Northwestern garter snake.

It was apparent that edge effect was an important factor for the occurrence of most species in segment 2. The most abundantly encountered amphibian was the Northern red-legged frog. The Pacific treefrog, also widely distributed, is likely to be in greater abundance than was evidenced. Among the reptiles, the Northwestern garter snake was found in greatest numbers in the segment, followed by the red-spotted garter snake.

Shrub willow appeared to be the least likely habitat to support populations of amphibians and reptiles in segment 3. The presence of permanent ponds within an area usually enhanced the number of species encountered regardless of the type of habitat. Within the segment, Bachelor Island (sampling area 12) is considered an important locality for the Western painted turtle. It was the only area west of Boardman (RM 270) at which the species was found. The western toad, also infrequently encountered, is also present at this site. The most common amphibians were the Pacific treefrog and longtoed salamander. The most common reptile was the Northwestern garter snake.

The abundance of species censused at sampling areas established within segment 4 was generally low. Of the habitats examined, rip-rap appeared to be the least important to either amphibians or reptiles. Most species were encountered in either Douglas fir/maple, oak, or oak/pine. Those habitats would seem to be of greatest importance to reptiles and amphibians in the segment. The most commonly encountered reptile species in the segment was the Western fence lizard. Pacific treefrog was the most common amphibian. Although not so indicated from the census, Oregon rattlesnakes

are suspected to occur in substantial numbers in some parts of this segment.

Most habitats censused in segment 5 appeared to be sparsely inhabited by reptiles and amphibians. The Pacific treefrog was found to be the most abundant species.

The most abundant amphibian species encountered in segment 6 of the study area were the Great Basin spadefoot toad and Woodhouse's toad. Spadefoot toads could be found in abundance in every habitat in which ponds were present during the breeding season. Woodhouse toads were present in these areas also but at lower densities. Woodhouse toads were the only amphibians encountered on islands visited in this segment. This species is probably the major amphibian component of the island fauna of this segment. The sagebrush lizard was the reptile encountered most often in the segment. Within the confines of the Umatilla NWR, sagebrush lizards were extremely widespread on the Oregon shore and islands. The species was not found on the Washington shore. Gopher snakes and Western yellow-bellied racers were common on the refuge, though rather diffusely distributed. Sites where Western painted turtles were encountered are considered important because the species was found in only a small number of sites within the study area.

Five of the 31 species of amphibians and reptiles identified on the study area are listed in the U.S. Fish and Wildlife Service's 1973 list of Threatened Wildlife of the United States or Storm's (1966) Endangered Amphibians and Reptiles of Oregon as being species of undetermined or potentially threatened status in some part of their range. This list includes the Pacific giant salamander, rough-skinned newt, Larch Mountain salamander, tailed frog, and short-horned lizard.

HUMAN USE OF WILDLIFE RESOURCES

Types of human use of wildlife resources observed within the study area during this study included hunting big game, waterfowl, furbearers, and upland game birds; trapping aquatic and terrestrial furbearers; harvesting wild strawberries, blackberries, mushrooms, and asparagus; observing wildlife; and photographing wildlife and scenery.

Human uses related to wildlife in segment 1 included hunting of waterfowl, trapping, harvesting of wild strawberries, wildlife observation, and photography. With the exception of trapping of furbearing animals, most of the use was concentrated at Fort Stevens and Fort Canby State Parks.

Hunting, trapping, wildlife observation, and photography were the human uses observed in segment 2. Though waterfowl hunting was observed in many locations, it was heaviest within the Lewis and Clark NWR. Hunting of furbearers, especially nutria was observed between RM 19 and 38. Trappers directed their efforts toward nutria and beaver, but terrestrial furbearers were sought also. Trapping effort appeared to be concentrated between RM 23 and 35. Wildlife observation and wildland appreciation were the principal human uses of Lewis and Clark NWR and the Columbian White-tailed Deer NWR.

Human use in segment 3 included photography, wildlife observations, harvesting blackberries and mushrooms, trapping, and waterfowl hunting. Non-consumptive uses were prevalent at Ridgefield NWR and Sauvie Island WMA. Evidence of trapping was observed throughout the segment, though it appeared to be much less intensive than in segments 1 and 2, yet greater than in segment 4-6. Waterfowl hunting was concentrated at Sauvie Island, Ridgefield NWR, and on the Washington shore between RM 94 and 102. Upland game bird and big game hunting was reported at Sauvie Island WMA.

The only uses observed in segment 4 were waterfowl hunting, trapping, wildlife observation, and photography, the latter two being the primary uses. Waterfowl hunting in this segment was the lowest of all segments.

Human use of wildlife resources in segment 5 included hunting of upland game birds and waterfowl, trapping, photography, and wildlife observation. During this study the principal use appeared to be upland game bird hunting.

The major human use in segment 6 was hunting. Trapping, harvesting of wild asparagus, wildlife observation, and photography were also observed.

EFFECTS OF PEAKING

Assessments of impact were based upon the assumption that power peaking operations will result in more frequent and severe fluctuation of water levels. It was also assumed that changes in water levels due to peaking would be minimal downstream from Portland (RM 105). Therefore, wildlife and wildlife habitat in that portion of the study area (RM 0-105) would experience no impact from peaking operations. Estimates of the effects of power peaking on wildlife and wildlife habitat are presented only for segment 4-6 and the upstream 60 percent of segment 3.

Vegetative Types and Land Form Classes

All vegetative types and land form classes immediately adjacent to the shoreline and others at an elevation within operating limits plus wave height will be affected by periodic inundation or wetting as a result of power peaking operations. The habitats, listed in order from lowest to highest in elevation, most likely to be inundated and exposed most frequently include the following: sand, gravel, and mud beach; rip-rap; marsh; shrub willow; large willow; mixtures of willow and other species of trees; reed canarygrass; and cottonwood.

Specific changes in vegetative communities cannot be predicted without additional information, however, one probable effect of power peaking operations will be to accelerate erosion of portions of the shoreline vulnerable to wave action. This erosion will have an especially important impact on islands in this portion of the study area. It is probable that these islands will be inundated, reduced significantly in size, or eliminated as a result of water fluctuations due to power peaking.

Big Game

The magnitude of impact of power peaking on big game populations of the study area will probably be slight. Densities of all big game species are low and with one exception (mule deer in the upper portion of segment 6) do not appear to depend on that portion of the shoreline which will be affected by power peaking operations.

Within the upstream 25 percent of segment 6, mule deer appear to use intensively riparian habitats in portions of the shoreline within pool operating limits. Fluctuation of water levels due to power peaking in this portion of the segment would probably be relatively severe due to the proximity of McNary Dam and the "tailwater effect". It is probable, therefore, that mule deer use of this riparian vegetation would be reduced or possibly eliminated depending on the extent of change in vegetative communities. In addition, islands in the upper portion of the segment appeared to be of special importance to mule deer populations as "fawning" areas. Mule deer probably select islands for fawning because of the lack of predators, primarily coyotes. The possibly severe water level fluctuations due to power peaking near McNary Dam could also result in reduction or elimination of these island fawning areas.

Waterfowl

Power peaking will likely have a major detrimental impact on waterfowl populations of the study area. Both resident (breeding) and migrant populations of ducks, geese, swans, coots and grebes will experience detrimental effects.

Resident populations, especially Canada geese, will probably suffer the greatest impact as a result of decreased reproduction. Water regulation for power peaking could destroy much of the nesting and brooding habitat for geese which is already in short supply. All nesting areas identified were on islands. These islands may be inundated, reduced in size, eliminated, or connected to the mainland (allowing easy access of predators) as a result of water level fluctuation. Brooding habitat may be reduced if power peaking destroys present brooding areas by altering or eliminating flora and insect fauna or by flooding forage.

Production of ducks can also be expected to decline in the study area as a result of power peaking operations but may be less severe than that for geese. Low densities of 15 species of ducks are reported to nest in segments 3-6. Of these, the mallard is the major nesting species. Impacts of peaking on nesting and brooding areas will probably be affected in ways similar to those discussed for geese. However, ducks were found to nest on the Oregon and Washington shorelines in addition to the islands. Some nests were located in riparian vegetation within operating limits of water levels.

Large numbers of migrant ducks, geese, swans, grebes, and coots use the study area in fall, winter, and early spring. Segments 4-6 alone, provided approximately 21,000,000 waterfowl days-use during September 1974-March 1975. Major use appeared to be primarily for resting in preferred sites on gravel and sand bars and especially islands. Peaking operations will likely inundate many of these resting areas for at least a portion of the day. Erosion (accelerated by power peaking) could also destroy some resting areas. Portions of the study area were also used by some migrant species of waterfowl for feeding. Specific foods of waterfowl in the study area and the possible effects power peaking may have on foods is not known, however, the availability of food could be reduced as a result of increased or decreased water depth in shallow feeding areas.

Aquatic Furbearers

Power peaking can be expected to have major negative impacts on aquatic furbearer populations in the study area. Aquatic furbearers inhabit and utilize the water and immediate shoreline. All or most of their food is obtained from the aquatic environment or from the riparian zone of the shoreline. Increased fluctuation of water levels could seriously reduce food supplies of aquatic furbearers. Dens in which these mammals give birth are located on the shoreline at or very near the waterline characteristically. The young of all species defined as aquatic

furbearers for purposes of this study, except nutria, are essentially helpless for a period of time after birth, and therefore, are vulnerable to drowning if dens are flooded or predation if underwater den entrances are exposed by low water levels.

Extreme and frequent water fluctuations during April-August would be detrimental to beaver production in the study area and water fluctuations during May and June would be most detrimental to muskrat production. The critical period for water fluctuations is April-June for young otter and mink.

Populations of all species of aquatic furbearers within that portion of the study area upstream from Portland (RM 105) can be expected to decline in numbers as a result of power peaking. Beaver and muskrats will likely be reduced in numbers more severely than nutria, river otter, and mink.

Terrestrial Furbearers

All species of terrestrial furbearers found in the study area occur in that portion of it to be affected by power peaking. The probable effects of power peaking appear to be similar for all species of terrestrial furbearers, therefore, estimates of these effects are presented for all species combined. Detrimental effects of increased frequency and severity of water fluctuations will probably include: (1) flooding of dens and drowning of young, (2) increased highway and railroad mortality, and (3) reduction of size of prey populations. Beneficial effects of power peaking could result from increased availability of food.

Raccoon and opossum populations will likely experience a net detrimental impact of moderate magnitude from power peaking operation. These species were found to occur primarily in riparian habitat. Red fox were found only downstream from Bonneville Dam (RM 146), but the population will probably experience major negative impacts because the species was associated primarily with riparian habitat including islands of low elevation. Striped skunks, spotted skunks, and grey fox populations will probably receive a slight negative impact as a result of beneficial effects almost balancing negative ones. Coyote and bobcat populations might possibly experience a slight beneficial impact from power peaking through increased accessibility of prey and carrion. Badgers will probably receive essentially no impact from peaking because of their disassociation with shoreline habitat.

Birds Other Than Waterfowl

An increase in the frequency and magnitude of water fluctuations will affect birds both directly and indirectly. The extent of effects will vary with the magnitude of fluctuations, their duration, and the time of year at which they occur.

High water levels during the breeding season could result in reproductive failure or decrease reproductive success of those species that nest on or near the ground. Swainson's thrush and song sparrows will experience severe negative impacts from peaking. Gulls and terns nesting on islands in segments 5 and 6 are particularly vulnerable since many islands will be reduced in size or inundated as a result of high water. Foraging area for those species that forage on or near the ground will also be reduced as a result of high water levels. Scavengers, such as the turkey vulture, bald eagle, and gulls, and opportunistic foragers, such as the great blue heron and black-crowned night heron, may experience benefit from an increase in water fluctuations because of stranded prey items in shallow pools created by receding water and carrion left on shore also by receding water.

Increased turbidity of water, which could result from power peaking, would decrease the foraging success of diving birds (i.e., loons, grebes, cormorants, scoters, mergansers) which rely on vision to find their prey.

Any affects power peaking may have on riparian vegetative communities serving as habitat or food source for many species of birds must be considered in addition to those discussed above.

Small Mammals

Populations of small mammals found to occur in riparian habitats within operating limits of water levels will probably be eliminated or reduced in size within the study area due to increased water fluctuations. In addition, power peaking will probably reduce species diversity and abundance of small mammals in the study area.

Small mammals that spend much of their time under ground such as moles, gophers, and hibernating and/or estivating ground squirrels and other rodents (e.g., Ord's kangaroo rat, Great Basin pocket mouse) will be eliminated from habitats flooded frequently. Less mobile species, primarily the smaller shrews and mice, may also be eliminated or severely reduced in numbers within riparian habitats. More mobile (and larger) species of small mammals (squirrels, chipmunks, weasels, rabbits, hares, and rats) will receive less negative impact from peaking because they could escape high water levels, but may experience increased predation and stress as a result of crowding in areas of higher ground.

Bats

Peaking operations will probably not have very dramatic effects on local populations of bats because the density of bats appeared to be low in the study area. The major effect of peaking operations on bats would be the effect of changing water levels on riparian vegetation and the insect (prey) populations associated with it. An increase in riparian vegetation would probably increase insect populations and might increase feeding activity of bats in the study area. Correspondingly,

if peaking operations decrease riparian vegetation, insect populations would likely decrease and, thus, limit the numbers of bats utilizing shoreline areas for feeding.

Reptiles and Amphibians

The potential impact of increasing the frequency and amplitude of water fluctuations on reptiles and amphibians can be separated into the categories of direct and indirect effects. Under direct effects are placed such things as mortality (from drowning), the disruption of sites of amphibian and reptile egg deposition, and general habitat displacement. The possible expansion of suitable habitat for amphibians and reptiles under certain circumstances is a beneficial effect which is not immediately recognizable but must be kept in mind. Indirect effects include changes in food resources of affected species. Such changes will be realized for all but are likely to be more noticable for species utilizing other vertebrates as food.

The magnitude of the most direct effect, mortality, will be largely dependent upon the season in which new controls are initiated. Should the change occur during winter hibernation, high mortality of reptiles other than snakes is probable. Amphibians, in general, may survive such a change better than reptiles, though mortality from drowning is likely to occur. Initiation of regulatory changes during seasons in which amphibians and reptiles are active (spring, summer, fall) is likely to induce more generalized mortality if high waters come during daily periods of inactivity.

Human Use of Wildlife Resources

Power peaking will cause indirect impacts on all human use of the study area and direct impacts on a portion of them. Indirect effects resulting from reduction or elimination of wildlife resources will produce the greatest impact. Direct effects will include: (1) reduced access to waterfowl hunting areas, (2) decreased attraction of waterfowl to established hunting areas, (3) increased vulnerability of game birds and big game during periods of high water, (4) severe reduction in effectiveness of trapping techniques for aquatic furbearers.

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PROJECT PERSONNEL

Howard Wight was project leader. He was especially instrumental in stimulating initiation of the overall study. Charles Meslow assumed the position of project leader and directed the study after Wight's death in July 1975. Jim Tabor, field supervisor, was responsible for preparation of the study plan, execution of field studies, and preparation of interim and final reports.

Rick Breckel and Keith Miles assisted in field studies. Laurel Keller assisted in preparation of the study plan and final report. Christine Spring and Kaaren Smalter assisted in analysis of data and preparation of final report. Jeanne Jensen, Virginia Veach, Alma Rogers, Mary Exner, and Estalee Baldwin performed clerical and record keeping tasks.

Project investigators, those persons responsible for conducting individual phases of this study, are listed on the following page. Results of their efforts, in an edited form, are presented in this report.

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AID TO READER

The results of this study are presented in 13 major sections representing the component parts of the research effort. Presentation of results in each major section is by segment of the study area. For most sections involving groups of wildlife, results are further organized by type of habitat within each segment.

Species of plants and animals identified in this study are referred to primarily by common name throughout this report. Scientific names, and the authority used, are presented in tabular form in each major section of the report involving plants and animals. Scientific and common names are presented in the following tables:

Table 16 - Plants
Table 99 - Big game
Table 101 - Waterfowl
Table 116 - Aquatic Furbearers
Table 123 - Terrestrial Furbearers
Table 130 - Birds other than Waterfowl
Table 238 - Small Mammals
Table 253 - Bats
Table 258 - Reptiles and Amphibians

Most locations mentioned in this report are identified by river mile (RM) of the Columbia River. We have not supplied a map of the study area but assume that one with river miles denoted will be enclosed with the report upon distribution. Locations of intensive sampling areas are planned to be identified on photo mosiacs (Appendix A).

Appendix D, results of the intensive goose study done on Umatilla NWR, had not been completed at the time this report was submitted. If Appendix D is completed before the report is printed and distributed, it will be included in the report.

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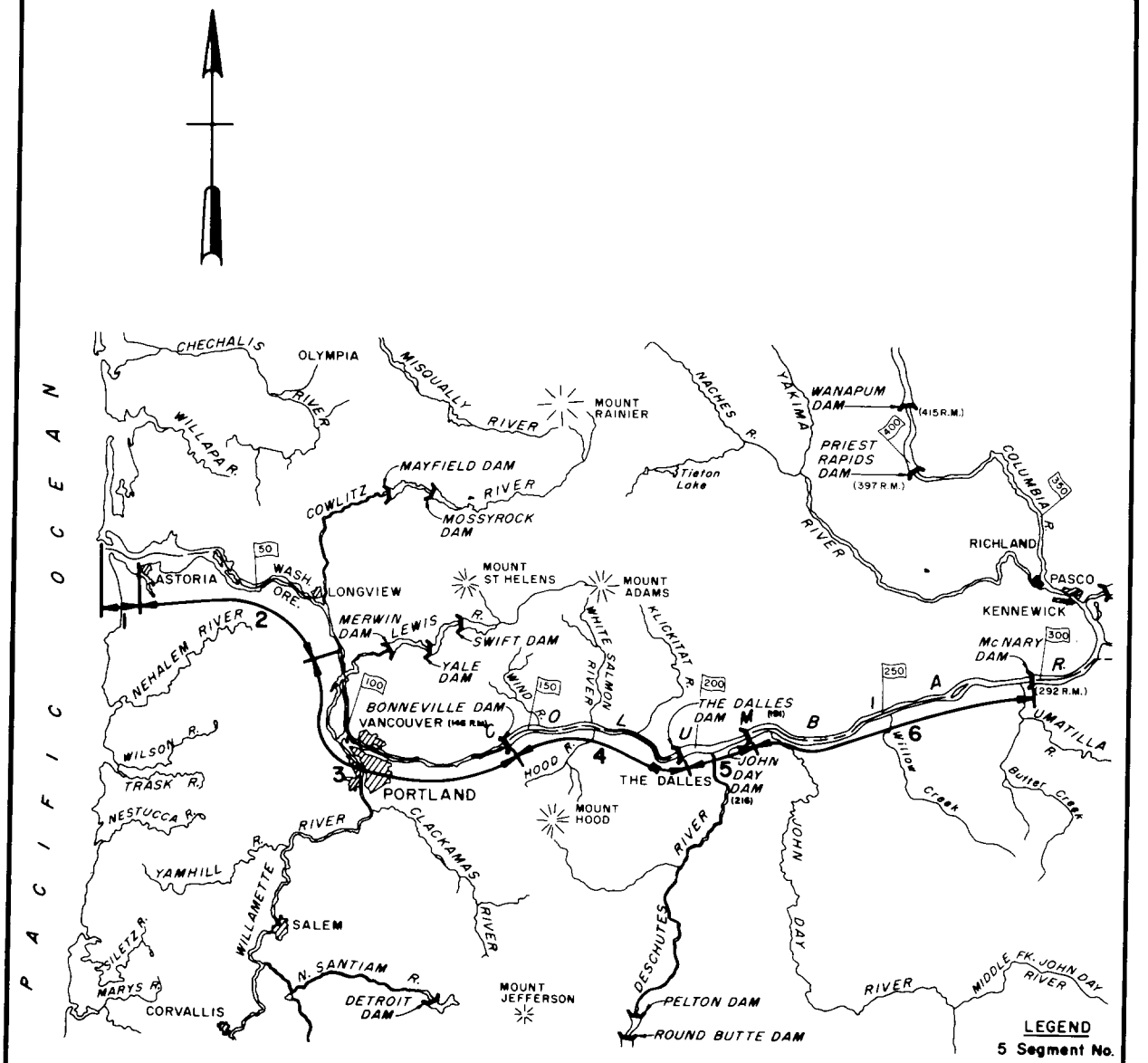

NOT TO SCALE

FISHERIES ENGINEERING RESEARCH PROGRAM
INVENTORY OF RIPARIAN HABITATS
1973 – 1975
OREGON STATE UNIVERSITY
STUDY AREA
COLUMBIA RIVER
RM 0 TO RM 292
U.S. ARMY ENGINEER DISTRICT, WALLA WALLA

I. INTRODUCTION

Plans have been made to change the power supply system of the Columbia and Snake Rivers from a hydroelectric to a thermal based system which would require supply of peak power demands by hydroelectric projects. Hydroelectric projects have the ability to vary output rapidly; thermal plants do not. Operation of all hydroelectric projects will be closely coordinated to get maximum use of water in the system for power production. As a result, river flows and pool levels will fluctuate on a substantially different daily, weekly, and seasonal regime than at present. An increase in frequency and severity of water fluctuations will result from power peaking operations. Under the peaking program, no spilling of water except for fish passage is anticipated except during years and periods of extremely high runoff. Flows will cease, tailwaters will drop to minimum and pool levels raised to maximum between peak power production periods. During peak production, water will flow through turbines, tailwater levels will increase to maximum and pool levels will drop to minimum.

Flooding of riparian habitat in order to create existing hydroelectric projects drastically reduced wildlife habitat and wildlife was lost. Now, modification of project operation for power peaking further threatens wildlife resources associated with the Columbia and Snake Rivers. It was determined that research was needed to assess the impact of water level fluctuations due to power peaking on riparian habitats and their associated wildlife populations.

A Wildlife Working Committee, named to coordinate wildlife research as it relates to water regulation of the Snake and Columbia Rivers, determined that an inventory of riparian habitats and associated wildlife populations was the first research priority. The Committee further wanted this inventory information to be used in making preliminary assessments of proposed river regulation impacts upon riparian habitats and wildlife. The area of interest as stipulated by the Wildlife Working Committee was the Columbia River from its mouth to the Canadian border and the Snake River upstream to and including Brownlee Reservoir. This is a total distance of approximately 1,100 river miles.

The U.S. Army Corps of Engineers contracted the Oregon Cooperative Wildlife Research Unit, Idaho Cooperative Wildlife Research Unit, and the Department of Forest Resources of the University of Washington to conduct the inventory and make preliminary assessments of the impacts of peaking on wildlife and habitat. The study was broken down into three parts on the basis of areas to be studied. The Oregon CWRU was responsible for studies along the Columbia River from its mouth (RM 0) to McNary Dam (RM 292). The Idaho CWRU inventoried that portion of the Snake River from the upper end of Brownlee Reservior (RM 344.9) to its confluence with the Columbia River and the Columbia River from RM 345.5 downstream to McNary Dam. The Department of Forest Resources of the University of Washington was responsible for studies along the Columbia River from the Canadian border downstream to RM 345.5.

This report represents the Oregon Cooperative Wildlife Research Unit's contribution to the overall study.

II. STUDY AREA

As stated above, the Oregon CWRU's study area was the Columbia River from the seaward end of the river mouth jetties to McNary Dam -- a distance of approximately 292 river miles. The study area was broken down into the following segments: (1) RM 0 to RM 12 (mouth of Youngs River), (2) RM 12 to RM 79, (3) RM 79 to Bonneville Dam (RM 145), (4) Bonneville Pool (RM 145-192), (5) The Dalles Pool (RM 192-215.6), and (6) John Day Pool (RM 215.6-292).

Study area boundaries for the Washington shore of the river were: (1) Burlington Northern Railroad from McNary Dam to Vancouver, (2) Great Northern-Northern Pacific-Union Pacific Railroad from Vancouver to Longview, (3) U.S. 830 from Longview to Cathlamet, (4) natural boundaries of relief and riparian vegetation from Cathlamet to Knoppton, (5) Washington 401 from Knoppton to Ilwaco, and (6) natural boundaries of relief and riparian vegetation from Ilwaco to the north jetty. Boundaries on the Oregon side were: (1) the railroad tracks from McNary Dam to Irrigon, (2) U.S. 730 from Irrigon to its junction with Interstate 80 N, (3) Interstate 80 N from the junction of U.S. 730 to Troutdale, (4) Union Pacific Railroad from Troutdale to Linnton, (5) Spokane-Portland-Seattle Railroad from Linnton to Warrenton, (6) Oregon 26 from Warrenton to Hammond, and (7) natural boundaries of relief and riparian vegetation from Hammond to the south jetty.

The highways and railroads listed above were used as study area boundaries except in areas where land less than 10 feet in elevation above high water line and embayments exist on the landward side of them and in areas where the distance and relief between the shoreline and highway or railroad is great. Areas less than 10 feet in elevation above high water elevation and embayments on the landward side of highways and railroads used as general boundaries were included in the study area. The study area boundary was placed around these areas on the basis of relief and landward extent of riparian vegetation. In areas where the distance and relief between the shoreline and the railroad or highway was excessive in view of the objectives of this study, the boundary was located between the highway or railroad and the high water elevation, using the most convenient natural or man-made boundaries. In segments 5 and 6, all Corps lands were included in the study area.

III. OBJECTIVES

1. Identify, delineate, and describe the riparian and associated upland habitats of the study area.

2. Establish indices and make population estimates where possible for wild vertebrate species, exclusive of fish, using these habitats.

3. Make preliminary assessments of proposed river regulation impacts upon these habitats and their associated vertebrate populations.

4. Gather information pertinent to human use of wildlife resources.

IV. LITERATURE REVIEW

GEOLOGY

The geological features of the study area are relatively recent in origin; they date from the lower Tertiary and later. The Astoria formation of the lower Tertiary marine sediments and Miocene Columbia River Basalt are the dominant geologic forms of the river west of the Cascades (Lowery and Baldwin 1952). Quaternary sediments of glacial waters and Portland gravels and sands were deposited in the Portland vicinity during the Pleistocene. Within the Columbia Gorge, Columbia River Basalt, characterized by dark-gray, fine grained rock, is overlayed by the Troutdale formation (Baldwin 1965). Conglomerate and quartzite pebbles of the Troutdale formation overlies the Sandy River mudstone of lower Pliocene origin. Moving east in the Gorge, the Dalles formation, which is characterized by sandstone and siltstone, rests on the Columbia River Basalt. West of Hood River, the Cascade Andesites cover the Troutdale formation.

Alluvium of recent origin overlies the basalt and various formations along great stretches of the lower Columbia River. Except for the alluvium deposits near Boardman, Columbia River Basalt and glacial stream deposits dominate the geology of the study area east of the gorge (Oregon Water Resources Board 1963).

SOILS

General information concerning soils within the study area was obtained from Franklin and Dyrness (1969), Knox (1962), and Anderson (1956).

Soil groupings of the study area are closely related to the geological structure. Alluvial and Humic Gley great soil groups occur over much of the study area because much of the Columbia River Valley is overlayed by alluvium.

Alluvial soils have a simple profile. The B horizon is lacking, the A horizon is light to dark and thin to thick, and the C horizon is composed of stratified layers of alluvium. The Humic Gley soils are present under meadows and are usually poorly drained. Its A horizon is composed of dark organic material. The B horizon is mottled (gleyed) with a greater clay content.

In the relatively warm, humid, forested areas adjacent to the lower Columbia River west of the Cascades, Reddish Brown Lateritic, Sols Bruns Acides, and Lethosol soils are present. Within the Columbia Gorge, Western Brown Forest soils characteristic of forest-steppe transition and associated Regosol and Lethosol soils predominate. East of the Cascades in the Columbian Basin, Rupert sand, a soil developed in alluvium, and Sierozem soil groups are most commonly found. Sierozem soils are light-colored and have A horizons with little organic matter.

County soil maps for many portions of the study area are available from the Soil Conservation Service. These maps identify soil types in specific locations along the study area. More detailed county soil maps can be examined at Soil Conservation Service offices.

CLIMATE

Climate of the study area was discussed by Franklin and Dyrness (1969), Lynott (1966), and Rudd (1962).

The study area can be divided into the following four regions based on climatic conditions: 1) west of the Cascades, 2) Willamette Valley and Puget Trough, 3) within the Columbia Gorge, and 4) east of the Cascades.

West of the Cascade range, a maritime climate characterized by mild temperatures, heavy precipitation, and cool, dry summers exists. Precipitation west of the coastal mountains averages 50-80 inches annually, 75-85 percent of which (mostly rain) falls between 1 October - 31 March. At Astoria, the annual precipitation is 90-120 inches. The mean temperature in January is 48° F, and the mean temperature is 68° F in July. There are approximately 200 frost-free days per year in this portion of the study area (Rudd 1962).

The Willamette Valley and Puget Trough portion of the study area receives an annual precipitation of 30-50 inches. The frost-free season is 160-200 days. Portland's average annual precipitation is approximately 42 inches. Temperatures average 40° F in January and 68° F in July (Franklin and Dyrness 1969).

The Columbia Gorge is an area of transition from the marine-type climate of western Oregon and Washington to a continental-type climate to the east (Lynott 1966). Rainfall within the gorge decreases from west to east. Average annual precipitation within the gorge is 75.6 inches at Cascade Locks; 30.1 inches at Hood River; and 13.8 inches at The Dalles (Lynott 1966). Weather disturbances occur frequently in the gorge, particularly during winter when winds often blow from the east. Summer winds, often of high velocity, are mainly from the west.

East of the Gorge, a continental climate predominates. Temperatures fluctuate widely both seasonally and daily. Annual precipitation is in the 10-20 inch range. Average annual precipitation at Umatilla is 7.83 inches (Lynott 1966). Precipitation is less seasonal than in other portions of the study area. Fifty-five to 75 percent of the precipitation falls between 1 October and 31 March (Rudd 1962). Annual snowfall averages 10-30 inches and contributes significantly to the annual precipitation.

VEGETATION

The study area passes through the following six major vegetational zones described by Franklin and Dyrness (1969): 1) *Picea sitchensis*,

2) *Tsuga heterophylla*, 3) interior valley, 4) *Pinus ponderosa*, 5) *Pseudotsuga menziesii*, and 6) shrub-steppe.

The *Picea sitchensis* zone is a narrow vegetative band along the Pacific coast. Approximately the first 20-25 miles of the study area is within this zone. Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*) are the most common coniferous species. Sand dune and strand communities, tidal marshes, and forested swamps occur near the mouth of the Columbia River. The sand dune and strand communities are typified by sand colonizers and stabilizers, dense shrub communities, and Sitka spruce. Tidal marsh communities are not well known, but do contain arrowgrass (*Triglochin maritima*), salt grass (*Distichlis spicata*), three-square (*Scrirpus americanus*), bulrush (*S. pacificus*), rushes, and other marsh plants. Western redcedar and red alder (*Alnus rubra*) swamps are also present along portions of lower Columbia River shoreline.

The *Tsuga heterophylla* zone encompasses that portion of the study area from the *Picea sitchensis* zone east to the crest of the Cascades within the Columbia Gorge except for a section near Portland. Western hemlock and western redcedar are the dominant climax species in this zone, but seral Douglas fir (*Pseudotsuga menziesii*) and red alder cover much of the forested areas. The most common hardwood species in upland habitats are red alder and big leaf maple (*Acer macrophyllum*). The dominant hardwoods in riparian habitats of this zone are black cottonwood (*Populus trichocarpa*), willows (*Salix* sp.), Oregon ash (*Fraxinus latifolia*), and red alder. Typical understory plants are oceanspray (*Holodiscus discolor*) and salal (*Gaultheria shallon*) on the drier sites, vine maple (*Acer cirinatum*) and Oregon grape (*Berberis nervosa*) on mesic sites, and swordfern (*Polystichum munitum*) and Oregon oxalis (*Oxalis oregana*) on areas with greatest moisture.

The interior valley zone includes that portion of the study area near Portland. Forest stands, and groves and savannas dominated by Oregon white oak (*Quercus garryana*) are typical of this zone in its northern extent near the study area. Riparian habitats are typified by Oregon ash, black cottonwood, bigleaf maple, red alder, and willows. Extensive stands of almost pure black cottonwood occupy many of the islands and line the shores of the Columbia River in this zone.

Within the Columbia Gorge, narrow belts of the *Pseudotsuga menziesii* and *Pinus ponderosa* zones are present. Douglas fir forests dominate the lower elevations in the western portion of the Gorge. Moving east in the Gorge, Douglas fir is replaced by a narrow zone of Ponderosa pine. Oregon white oak is associated with the *Pinus ponderosa* zone and is most prevalent at the eastern edge.

The remainder of the study area east of the *Pinus ponderosa* zone is within the shrub-steppe (*Artemisia* dominated) zone. Climax communities in this zone are dominated by sagebrush/bunchgrass associations on Sierozern soils. Big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Pursia tridentata*), low sagebrush (*A. arbuscula*), and rabbitbrush (*Chrysothamnus* sp.) are typical dominant shrubs near the Columbia River within this zone. Bluebunch wheatgrass

(*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), Sandberg bluegrass (*Poa sandbergii*), and cheatgrass (*Bromus tectorum*) are the most common grasses.

There are few specific studies of the flora within the study area. Detling (1966) discussed the flora of the Columbia Gorge. He described the Douglas fir/bigleaf maple forests of the west end of the Gorge, vegetational patterns at the lower elevations of the eastern end of the Gorge, and flora of the lateral canyons, including species lists. He did not specifically discuss the riparian vegetation. Poulton (1955 and 1962) and Daubenmire (1942 and 1970) described climax plant communities of upland habitats in the vicinity of the eastern portion of the study area. Anderson (1956) described soil-plant relationships that occur near the Columbia River in the Columbia Basin, which includes the eastern extent of the study area. No specific discussion of riparian vegetation of the eastern portion of the study area was found.

Specific information concerning riparian vegetation associated with the Columbia River is limited to unpublished reports of David B. Marshall of the U.S. Fish and Wildlife Service, and a report prepared by the Stanford Research Institute (1971) for the Portland District, U.S. Army Corps of Engineers. Information from both of these sources covers only part of the study area and is rather general in nature. Vegetative descriptions were based on reconnaissance observations; no vegetative sampling was conducted.

Marshall (Unpublished reports) conducted surveys of the vegetation of approximately 20 islands in the lower Columbia River between Tongue Point, Oregon (RM 18) and Cathlamet, Washington (RM 40). He described the general vegetative patterns found on each of the islands and made a list of plants present. Tidal marshes that are inundated twice daily by tides cover approximately two-thirds of the island acreage. These tidal marshes are dominated by the following species of plants according to Marshall:

Hardstem bulrush	*Scirpus acutus*
Broad-leaved cattail	*Typha latifolia*
River bulrush	*Scirpus fluviatilis*
Slough sedge	*Carex obnupta*
Rush	*Juncus* sp.
Arrowhead	*Sagittaria cuneata*
Water plantain	*Alisma plantago aquatica*
Smartweed	*Polygonum persicaria*
Horsetail	*Equisetum hyemale*
Aster	*Aster* sp.
Water hemlock	*Cicuta* sp.
Fireweed	*Epilobium* sp.

Those portions of the islands subject to daily flooding by tides for a shorter duration of time support extensive stands of willow, creek dogwood, Sitka spruce, black cottonwood, and red alder as dominants.

Marshall (Unpublished report) described the typical pattern of vegetational zonation on islands having both low (below mean high tide) and high (above mean high tide) ground. Moving from elevations within the tidal influence to higher elevations, typical vegetational zones are as follows: 1) hardstem bulrush; 2) river bulrush; 3) hardstem bulrush with smartweed and/or arrowhead; 4) hardstem bulrush with aster, water hemlock, rushes, grasses, horsetail, and others; 5) cattail; 6) willow with sedge understory; 7) cottonwood, willow, and spruce with a dense understory of herbs and grasses.

The Stanford Research Institute's (1971) report contains some specific information concerning riparian vegetation of that portion of the study area from The Dalles Dam (RM 192) to the Interstate 5 bridge between Portland and Vancouver (RM 106). Plants within the littoral zone were classified into aquatic vegetation (floating and submergent species), emergent vegetation (plants of mid-shoreline) and upland-emergent vegetation (plants in water-logged soil). Less than 20 species of plants were found to occur within the riparian zone. Aquatic vegetation occurs primarily in embayments and other protected sites, rarely in the main river. Prominant species of aquatic plants are sago pondweed (*Potomogeton pectinatus*), water-weed (*Elodea canadensis*) and free floating aquatics of the Lemnaceae. Yellow willow (*Salix lasiandra*) and brush willow are the dominant emergent vegetation in the zone of periodic inundation. Reed canarygrass (*Phalaris arundinacea*) occurs both as an understory and as a dominant on the upper margins of shorelines. Shoreline vegetation of embayments and backwaters within this mid-shoreline zone contains primarily sedges, horsetail, rushes, and willow; a few embayments having shallow overflows containing broad leafed cattail. Black cottonwood dominates that portion of the shoreline between the mid-shoreline to the upper limits of the flood plain. Understory species to cottonwood stands include blackberry (*Rubus laciniatus*), salmonberry (*Rubus spectabilis*), and grasses (mostly introduced species). Red alder, white oak, and dogwood occur as upland emergents.

REPTILES AND AMPHIBIANS

The distribution of 23 species of amphibians and 22 species of reptiles include portions of the study area (Stebbins 1954 and 1966, Owen 1940 and Slater 1963 and 1964). The Cascades frog (*Rana cascadae*) may not occur within the study area because it normally inhabits higher elevations in the Cascades. The green sea turtle (*Chelonia mydas agassizi*) may possibly be present even though it has not been collected near the study area.

Three species of salamanders (Pacific giant salamander, Larch Mountain salamander, and Oregon Dender salamander) and one lizard (leopard lizard) are listed as rare in Oregon (Storm 1966a). The Larch Mountain salamander is classified as "status-undetermined" in the U.S. Department of the Interior's "Red Book" (1973). This species was discovered in 1953. It has a very limited range in the western end of the Columbia Gorge. The Oregon slender salamander has been collected only in Oregon from the west slope of the Cascades. The leopard lizard reaches the northern limits of its range in a relict population near Hat Rock, Oregon.

Collection locations given for reptiles and amphibians by Owen (1940) and Slater (1963 and 1964) were useful in compiling a list of species possibly occurring in the study area.

Storm (1966b) presented a species list of reptiles and amphibians found in the Columbia Gorge and discussed the effect of the Columbia River on the distribution of reptiles and amphibians. Of 41 species occurring in the Gorge, only nine demonstrate at least some barrier effect by the river. The Gorge has allowed one species of reptile to extend its range from eastern Washington and Oregon to the western portions of these states. Two species of reptiles have reached eastern Washington and Oregon from the western side of the Cascades by way of the Gorge.

Reptiles and amphibians were inventoried by Battelle (1974) at the Trojan Nuclear Plant site on the Oregon shore at RM 72. The Northwestern salamander, long-toed salamander, rough skinned newt, Dunn's salamander, Western red-backed salamander, Ensatina, Pacific tree frog, bullfrog, red-legged frog, painted turtle, northern alligator lizard, Northwestern garter snake, and common garter snake were found on the site.

A wildlife resource inventory conducted by the Oregon State Game Commission in 1971 (unpublished report) provides some information concerning the occurrence and abundance of vertebrate wildlife including reptiles and amphibians by management unit and habitat for all portions of the study area.

MAMMALS

The broad geographical distribution of 100 species of mammals includes a portion of the study area. Ten of these species do not occur at low elevations and thus are not expected to be present in the riparian zone of the Columbia River.

The Columbian white-tailed deer (*Odocoileus virginianus leucurus*) is the only mammal found in the study area that is classified as endangered (U.S. Department of the Interior 1973). Olterman and Verts (1972) classified the Columbian white-tailed deer and the Canada lynx (*Lynx canadensis*) as endangered; Merriam's shrew (*Sorex merriami*) and white-footed vole (*Phenacomys albipes*) as rare; and fringed myotis (*Myotis thysanodes*), western pipistrelle (*Pipistrellus hesperus*), and Washington ground squirrel (*Spermophilis washingtoni*) as mammals of undetermined status possibly occurring within the study area in Oregon. Lauckhart (1970) lists the Columbian white-tailed deer, Canada lynx, Cascade red fox (*Vulpes fulva*), Ord kangaroo rat (*Dipodomys ordii*), pigmy rabbit (*Sylvilagus idahoensis*), white-tailed jackrabbit (*Lepus townsendii*), and western gray squirrel (*Sciurus griseus*) as rare mammals of Washington.

Specific information concerning mammal populations within the study area is limited, and is restricted primarily to the Columbian white-tailed deer, game species, and furbearers. Small mammals and other non-game species have received little attention. In addition, available information for mammal populations tend to be rather general in nature. Intensive studies

of populations within the study area are few in number.

Studies of the Columbian white-tailed deer have been conducted on the Columbian White-Tailed Deer National Wildlife Refuge near Cathlamet, Washington. Suring (1975) conducted a study to determine habitat utilization and movement patterns and estimate population size. T. Gavin, Ph.D. candidate Oregon State University, is currently studying the Columbian white-tails on the refuge.

Battelle (1974) conducted an inventory of mammals at the Trojan Nuclear Plant site in 1972 and 1973. The following species of mammals were observed at the site:

Beaver	Muskrat
Opossum	Deer mouse
Porcupine	Raccoon
Townsend chipmunk	Pacific mole
Striped skunk	Trowbridge shrew
Oregon vole	Vagrant shrew
Townsend vole	Dusky shrew
Shorttail weasel	Brush rabbit
Mink	Douglas squirrel
Nutria	Red fox
Shrew mole	Pacific jumping mouse
Black-tailed deer	

A species list of mammals associated with the lower Columbia River from Bonneville Dam to the river's mouth was presented by Ives and Saltzman (1970). The list is broken down into those species found in lowland (canals, sloughs, creeks, and lakes) and upland habitats. The list emphasizes furbearers, game species, and larger, more conspicuous species and is not a complete list of mammals occurring in the area. The information contained in the report was compiled from several special reports of the Oregon State Game Commission and from the files of district game biologists. A species list for mammals occurring in the Columbia Gorge (from western end near Bonneville dam to the confluence of the Columbia and Snake Rivers) was compiled by Gordon (1966). This list includes all groups of mammals except bats; 80 species were listed. Gordon also discussed the effect of the Columbia River on the distribution of mammals. Of the 80 species of mammals that occur near the Columbia River, 68 are found on both sides of the river, and 12 on only the Oregon or Washington sides. Stanford Research Institute (1971) listed only 32 species of mammals occurring within the littoral zone of the Columbia River from The Dalles Dam to the Interstate 5 bridge between Portland and Vancouver. This list is obviously incomplete.

The Oregon State Game Commission's wildlife resource inventory of 1971 (Unpublished Report) provided some general information concerning occurrence and population estimates for mammals in the Oregon portion of the study area. The information was broken down by habitat, management unit, and county. Population estimates were given in qualitative abundance categories of absent, few, medium, and abundant, and based on the knowledge of district

biologists. Sampling methods were not employed. Similar abundance ratings were given for muskrat (*Ondatra zibethica*), beaver (*Castor canadensis*), mink (*Mustela vison*), and nutria (*Myocastor coypus*) populations inhabiting Columbia Slough, Smith and Bybee Lakes, and Kelly Point and Hayden Island in Multnomah County, Oregon by the Oregon State Game Commission (1972a).

Claire, Scott, and Sanford (1971) estimated the number of beaver, muskrat, mink, river otter (*Lutra canadensis*), black-tailed deer (*Odocoileus heminous columbianus*) and Columbian white-tailed deer utilizing the Columbia River and adjacent riparian habitat from The Dalles Dam to Astoria (Table 1). The methodology used to make these estimates was not discussed. There were 243 beaver harvested from this portion of the Columbia River by Oregon trappers in the 1972-73 trapping season (Oregon State Game Commission, Unpublished reports).

Table 1. Population estimates of mammals of the Columbia River and adjacent riparian habitat from The Dalles Dam to Astoria.

Species	Bonneville Pool	Bonneville Dam to Columbia Co. line	Columbia Co. line to Astoria
Beaver	150	300	2,000
Muskrat	50	1,000	5,000
Mink	100	500	1,500
River otter	25	50	150
Black-tailed deer	No estimate	300	400
White-tailed deer	No estimate	few	250

Harbor seals (*Phoca vitulina*) inhabit the lower Columbia River but are not year-round residents according to Pearson (1969) who studied the seals and sea lions of the Oregon coast. Pearson identified "haulouts" of harbor seals at Desdemona Sands, Taylor Sands, Channel Sands, Grays Bay, Green and Seal Islands, and the ship channel east of Miller Sands. He also made estimates of the number of seals using the lower Columbia River during 1967-68.

Annual population estimates for game species are available for state game management units from the Washington Department of Game and Oregon Department of Fish and Wildlife. The estimates are of limited value, however, because the study area makes up only a portion of the management units.

BIRDS

Check-lists for birds of Oregon and Washington are available. Bertrand and Scott (1973) list and give general distributions, abundance, status, and preferred habitat for species of birds that occur in Oregon. A similar check-list for Washington birds was prepared by Alcorn (1971).

The California brown pelican, Aleutian Canada goose, tule white-fronted goose, prairie falcon, and peregrine falcon are classified as endangered, and the ferruginous hawk, osprey, western snowy plover, northern long-billed

curlew, Alaskan short-billed dowitcher, and western burrowing owl are classified as birds of undetermined status nationally (U.S. Department of the Interior 1973). Marshall (1969) classified 44 species of birds as endangered, rare, and status undetermined in Oregon.

List of birds observed or known to occur within the study area are available. Ives and Saltzman (1970) listed species of upland game birds (by habitat), waterfowl, shorebirds, wading birds, swimming birds, raptors, and a few of the more conspicuous birds that are known to occur along the Columbia River from Bonneville Dam to the river's mouth. A list of 100 birds (incomplete) was compiled from sightings and records of game agencies and private bird-watching enthusiasts by the Stanford Research Institute (1971) for birds of the Columbia Gorge. Marshall (Unpublished reports, BSF&W) recorded a list of 43 species observed on Tenasillahe Island 16 June 1970. Suring (Unpublished report) compiled a list of 113 birds observed by month, from July 1972 through June 1973, on the Columbian White-tailed Deer National Wildlife Refuge. One hundred-nineteen species were observed on Sauvie Island during the 1972 Christmas bird count conducted by the Audubon Society. The 1972 Portland Christmas bird count included 101 species.

Population estimates for species occurring within the study area are limited primarily to waterfowl and other migratory and game species. Aerial censuses of waterfowl conducted by the U.S. Fish and Wildlife Service provide the most complete population estimates for the study area as a whole. Aerial censuses are supplemented with ground censuses on Lewis and Clark, Columbian White-tailed Deer, Ridgefield, and Umatilla National Wildlife Refuges to provide frequent (bi-weekly or monthly) population estimates of waterfowl during the hunting season. Population estimates for other migratory and game species inhabiting the refuges are also made.

Bi-weekly counts of waterfowl on Sauvie Island Wildlife Management area and the Columbia River from The Dalles Dam to the John Day River (RM 218) are made by the Oregon Department of Fish and Wildlife during fall and winter.

Claire, Scott, and Sanford (1971) estimated daily average waterfowl, wading bird, and shore bird populations and times of use for species wintering and nesting on the Columbia River from Bonneville Dam to Astoria. Estimates are made for Bonneville Pool, that portion of the river from Bonneville Dam to the Columbia County line, and from the Columbia County line to Astoria. Nesting species of waterfowl listed were the Great Basin Canada goose, mallard, blue-winged teal, wood duck, and merganser.

Stanford Research Institute (1971) reported that waterfowl populations from The Dalles Dam to Portland was small compared to populations in the lower Columbia River. The Institute's study team located only two areas within the portion of the river examined that showed appreciable waterfowl use during the December and January field observations. One concentration area was near Steigerwald Lake and the other was near Memaloose Island. Geese were observed or reported to nest on McDonald, Pierce, and Hamilton Islands and near White Salmon, Washington.

Battelle (1974) inventoried birds of the Trojan Nuclear site in 1972 and 1973. Results of sampling indicated the occurrence of 102 species of birds at the site.

Marshall (Unpublished reports) estimated populations of waterfowl and some species of water birds and upland game birds on Tenasillahe Island and the islands between Tenasillahe Island (RM 35-39) and Tongue Point (RM 18).

The Oregon State Game Commission's wildlife resource inventory of 1971 (Unpublished report) provided qualitative population estimates for both game and non-game species by habitat. Since the estimates were made on a management unit and county basis, the information does not directly represent the study area, however. Annual population estimates of game species by state game management units and counties that are available from the Oregon Department of Fish and Wildlife and Washington Department of Game are of limited value for the same reason.

Bald eagles and ospreys are known to nest within the study area. Known eagle nest sites are on Grays Bay (Washington Department of Game 1973) and Tenasillahe Island (Marshall, Unpublished reports). Oregon State Game Commission (1972a) contains a map showing osprey nest sites in Oregon during 1970 and 1971. This map identifies two osprey nest sites on the Columbia River near the Hood River-Wasco County line. These two locations are probably the sites near Memaloose Island and Hood River that were mentioned by the Stanford Research Institute (1971).

Several great blue heron rookeries have been found on the study area. A map of 1970-71 great blue heron rookeries in Oregon shows the location of four rookeries within the study area; two in Clatsop, one in Columbia, and one in Morrow County (Oregon State Game Commission 1972b). A rookery on Bachelor Island near Ridgefield National Wildlife Refuge contained over 500 nests and produced an estimated 975 young in 1972.

HUMAN USE OF WILDLIFE RESOURCES

Information concerning human-use of wildlife resources within the study area was obtained primarily from published and unpublished material available from the Oregon Department of Fish and Wildlife, Washington Department of Game, and the Refuge Division, U.S. Fish and Wildlife Service.

Estimates of the number of waterfowl hunters on the Columbia River in Columbia and Multnomah Counties for 1971 were obtained from the Oregon Game Commission (1972b). These estimates are presented in Table 2. Recreational use of the Irrigon, Willow Creek, and Sauvie Island Wildlife Management Areas for 1971 were also obtained from this report (Table 3).

An estimate of the number of Oregon and Washington trappers that trapped furbearers within the study area can be approximated by the number

Table 2. Number of waterfowl hunters that hunted on the Columbia River in Columbia and Multnomah Counties in 1971.

County	Hunters		
	Duck	Goose	Snipe
Columbia	2,310	820	70
Multnomah	3,730	1,010	190
Total	6,040	1,830	260

Table 3. Recreation-days use of the Irrigon, Willow Creek, and Sauvie Island Wildlife Management Areas for 1971.

Area	Hunting				Trapping	Photography & Viewing
	Big Game	Waterfowl	Upland Game	Non-Game		
Irrigon	--	250	50	20	--	10
Willow Creek	--	300	150	20	--	210
Sauvie Island	27	11,445	2,000	270	80	32,103

of licensed trappers residing near the study area. In the 1972-73 trapping season, there were 75 licensed Oregon trappers (Oregon State Game Commission, Unpublished reports) and 43 licensed Washington trappers (Washington Department of Game, Unpublished reports) residing near the study area. Estimates of days-use provided by trapping cannot be made from available information.

Ives and Saltzman (1970) estimated the number of hunters and recreational-days use of the lower Columbia River below Bonneville Dam. Waterfowl recreational use of the Columbia River was exceptionally heavy. Approximately 16,000 hunter-days were estimated for waterfowl in this portion of the river in the 1969-70 season. Sauvie Island and islands below Tenasillahe Island accounted for a large percentage of the hunter-days. Approximately 1,500-2,000 hunter-days were devoted to waterfowl on the islands below Tenasillahe. Elk provided an estimated 2,100 hunters with 15,000 days of recreation. Deer provided 2,000 hunters with 13,000 days of recreation in this portion of the river.

An estimated 1,500 recreational days are produced annually hunting waterfowl, deer, rabbits, and pheasants on Government Island. Five hundred man-days of waterfowl hunting was realized from Smith and Bybee Lakes (Oregon State Game Commission 1972a).

Annual game harvest reports that include the number of hunters participating are available by county and administrative region from the Washington Department of Game. Estimates of man-days use of lands owned or controlled by the Washington Department of Game are also available. Estimates of hunter-days-use of big game, upland game, and waterfowl resources of the Washougal subregion of the Lewis basin and Grays, Elochoman, and Bear Nemah Naselle subregions of the south coastal basin in Washington are available from the Washington Department of Game are of limited value, however, because use specifically within the study area cannot be determined.

Estimates of human use of wildlife resources in Lewis and Clark, Columbian White-tailed Deer, Ridgefield, and Umatilla NWR's all of which are within the study area are available.

EFFECTS OF FLUCTUATING WATER LEVELS

Claire, Scott and Sanford (1971) discussed the potential impact of water fluctuations on wildlife populations associated with the Columbia River from The Dalles Dam to Astoria. They estimated that frequent, small fluctuations would have little adverse effect on wildlife. Severe fluctuations after sustained flows during nesting (1 March - 15 May) and rearing (1 April - 15 June) seasons would cause major waterfowl losses. Several species of shorebirds and the American bittern would be similarly affected, resulting in loss of nest sites located near the water's edge. Wading birds (great blue, green, and night herons) would probably not be affected because most nest in trees. Osprey will suffer losses of snag and stump nest sites in the Bonneville pool if water is raised substantially above present levels. During periods of high water levels, bird species (including young waterfowl) dependent on shoreline insect populations could suffer food shortages. Low water levels could, however, increase food supplies for shoreline scavengers.

Furbearer populations would be affected by fluctuating water levels during whelping seasons (March - April). Any rapid daily fluctuation exposing or flooding river bank den sites would be detrimental. Big game using lowlands of the Columbia River could suffer food shortages due to reduction of vegetation by frequent water fluctuations. Columbian white-tailed deer dependent on grass and sedge communities of the Columbia River lowlands could be adversely affected.

Impacts of fluctuating water levels on human-use of wildlife resources were also included in the report. An adverse effect on waterfowl hunting could result if water levels were exceedingly high or low during hunting season. Water levels below 4.0 feet msl would inhibit boat access to the shallow sloughs where hunting is best. On Sauvie Island, a level of 6.0 feet msl provides approximately 4,700 surface acres of water. A level of 2.5 feet m s l reduces this to 2,000 surface acres. High water levels would cause loss of aquatic food supplies in the flooded sloughs and thus reduce hunter opportunity. Hourly or daily river fluctuations could cause detrimental effects such as stranding, lack of access to hunting sites, and

loss of decoys. Access problems would hinder trappers and reduce the availability of furbearers. Reductions of wildlife populations resulting from fluctuating water levels could also reduce the non-consumptive recreational uses of wildlife resources of the Columbia River.

Stanford Research Institute (1971) discussed the potential impact of water fluctuations on vegetation, wildlife and recreational use of the Columbia River from The Dalles Dam to the Portland-Vancouver bridge. Submergent and aquatic vegetation would be adversely affected by increased water fluctuations. The willow shrub zone of vegetation located in that portion of shorelines currently inundated by periodic (seasonal and short-termed) water fluctuations would be expected to increase in size with greater water level fluctuations according to the S.R.I. report.

Estimated impacts of water fluctuations on bird and mammal populations were, in general, similar to those of Claire, Scott, and Sanford (1971), except that a greater emphasis was placed on possible beneficial effects. Species lists denoting estimated effects of increased water fluctuation were presented for birds and mammals. Of 95 species of birds listed, it was estimated that eight might experience adverse impacts, six might benefit, and 81 would incur no impact from increased fluctuations. Of 32 species of mammals, 7 were expected to experience adverse impacts, 7 were expected to benefit, and 18 were expected to incur no impact from increased water fluctuations.

Bell (1971) discussed the possible impact of proposed increased water fluctuation on waterfowl, shorebirds, wading birds, and furbearers of the Columbia River from The Dalles Dam to Vancouver. Much of the information contained in this report is from Claire, Scott, and Sanford (1971).

The Oregon State Game Commission and Washington Department of Game prepared a statement to comment on the Stanford Research Institute (1971) and Bell (1971) studies. This statement questioned the coverage and validity of the above consultants' conclusions. Lack of detail concerning wildlife populations and unsupported conclusions of the Stanford Research Institute (1971) report were criticized heavily.

V. METHODS

The general approach used in this study was to identify and delineate existing broad vegetative types (based on vegetative overstory) and land form classes (those areas without vegetation) within the study area and to stratify the sampling of vegetation, wildlife populations, and human use of wildlife resources by these vegetative types and land form classes (habitats). This approach was considered to be the most appropriate alternative because of the vastness of the study area.

Vegetative types and land form classes of primary interest were identified within each segment of the study area on the basis of acreage and elevation. Those types of habitat located near river elevation were considered to be of greater importance in this study than those of higher elevation within the study area. Intensive sampling areas were established in each major type of habitat identified according to the above criteria in each segment of the study area. A sampling area was established on both the Oregon and Washington shores in each of the major types of habitat that occurred in each segment unless the vegetative type or land form class did not occur on one of the shores. In segments 2 and 3 a sampling area was established in each major habitat on an island if it occurred on islands. This was done primarily to determine if occurrence and abundance of terrestrial animals differed on the Oregon, Washington, and island portions of the study area. Sampling areas were located in "homogeneous" stands of the vegetative types sampled and well inside their boundries where feasible in order to avoid possible "edge effect". In some portions of the study area, however, where vegetation occurred in narrow "bands", the edge effect was of great importance and sampling areas were established in these types of habitat. In addition sampling areas were established in some of the more common ecotones (i.e., zone of integration between two plant communities). Intensive sampling areas were not established on industrial, residential, or cultivated lands.

Inventory of species of animals requiring intensive sampling procedures (i.e., small mammals, songbirds, reptiles and amphibians, terrestrial furbearers, and big game) was done in the intensive sampling areas established in each segment of the study area. Estimates of species occurrence and abundance obtained from inventories conducted in a sampling area located in a particular habitat was extrapolated to include all of that type of habitat within the segment of the study area where the sampling area was located. Sampling of vegetation was also done in the intensive sampling areas. This sampling made it possible to describe the specific plant communities of the sampling areas.

Not all sampling was done in the intensive sampling areas. Some species of animals were more appropriately inventoried using "extensive" sampling procedures. Groups of species inventoried using extensive methods included waterfowl, raptors, shorebirds, colonial nesting birds, aquatic furbearers, and marine mammals.

A large amount of data concerning the occurrence and abundance of wildlife and human use of wildlife resources in the study area was gathered through supplimental observations made in addition to specific sampling and inventory

procedures. Approximately 1,200 supplemental observations were made during this study.

The study was divided into the following sub-studies primarily on the basis of compatibility of inventory methods: (1) delineation of broad vegetative types and land form classes, (2) description of vegetative communities, (3) inventory of big game, (4) inventory of waterfowl, (5) inventory of aquatic furbearers, (6) inventory of terrestrial furbearers, (7) inventory of birds other than waterfowl, (8) inventory of small mammals, (9) inventory of marine mammals, (10) inventory of bats, (11) inventory of reptiles and amphibians, (12) inventory of human use of wildlife resources, and (13) preliminary assessment of the effects of peaking on wildlife and wildlife habitat. Each of these sub-studies except marine mammals, human use, and assessment of the effects of peaking were conducted by a person or persons specializing in the specific field of knowledge involved. Individuals involved in this study are identified in the acknowledgements of this report.

The specific methodology used in this study is discussed below.

VEGETATIVE TYPES AND LAND FORM CLASSES

IDENTIFICATION AND DELINEATION OF BROAD VEGETATIVE TYPES AND LAND FORM CLASSES

Identification and delineation of vegetation and land form was accomplished by interpretation of aerial photographs. Photographs used were 9x9 in. black and white prints (scale = 1:22,000-1:25,000) obtained from the Portland District, U.S. Army Corps of Engineers. Dates of photograph coverage varied as to portion of the study area, with the most recent coverage 1973 and earliest 1966. Coverage of most of the study area was 1970 or later.

Vegetative types and land form classes delineated on the aerial photographs were verified by field observations made from air and/or ground checks. Initial verification in segments 1-3 was done in August and September 1973 by air. Segments 4-6 were checked from the ground in August 1973. Verification of habitat identification continued to a lesser extent through fall 1974. Classification of vegetative types was based solely on overstory composition.

Areas delineated on photographs were identified with a code number designating a particular vegetative or land form classification (Appendix B). Acreage estimates for delineated habitats were made from the photographs using a dot grid. Estimates of miles of shoreline for habitats immediately adjacent to the shoreline in segments 4-6 were also made from the photographs using a flexible rule.

INTENSIVE VEGETATIVE SAMPLING

Sampling of vegetation was done in intensive sampling areas for the purpose of describing the vegetative communities of these areas. Sampling involved the collection of quantitative data on specific vegetation attributes using recognized sampling methods including the canopy coverage by plot method (Daubenmire 1959), line intercept method (Canfield 1941), and point-centered-quarter method (Cottam and Curtis 1956).

Vegetative attributes measured in this inventory included: (1) ground coverage, (2) species presence, (3) frequency of occurrence, (4) basal area coverage (grasses, grasslikes, and forbs), (5) canopy coverage (shrubs and trees), (6) height (shrubs and trees), (7) dbh (trees), and density (shrubs and trees). Ground coverage estimates described coverage in terms of live vegetation, litter, rock, erosion pavement, and bare ground or soil.

Three basic categories of vegetation were sampled in this inventory. These categories were rangeland vegetation, forest vegetation, and marsh vegetation. The general approach and specific sampling methods used for marsh vegetation differed from that used for forest and rangeland vegetation. Specific sampling methods are discussed below.

Rangeland and Forest Vegetation

Two 50-foot vegetation sampling transects were located in a restricted random manner along a previously established animal sampling transect in each

intensive sampling area. Along each 50-foot transect, ten 20x50 cm microplots were located at 5-foot intervals. Ground coverage and basal area coverage of grasses, grasslikes, and forbs were estimated in each microplot. Canopy cover age of trees and shrubs was estimated from the 50-foot transects using the line intercept method (Canfield 1941). Density (plants/acre) of shrubs was obtained using five 100-square-foot (5.6 ft. radius) circular plots spaced at 12-foot intervals along each 50-foot transect. The point-centered-quarter method (Cottam and Curtis 1956) was employed to obtain density estimates for trees. Ten points (small mammal sampling stations located at 33 meter intervals along a transect) within each sampling area were selected in a restricted random manner. The distance to the nearest tree in each of the four cardinal directions was recorded. In addition, the height and dbh of each nearest tree was measured.

As a preliminary to the sampling procedure outlined above, a reconnaissance of each sampling area was conducted to construct a plant species list for the community and to note the overall topography, general soil type, and disturbance of the area.

Marsh Vegetation

The sampling scheme for marsh vegetation depended upon whether the marsh was located on a shoreline with an elevational gradient or on an area with no apparent slope.

Sampling of marshes with an elevational gradient was done within plots (0.5x0.5 m or 1.0x1.0 m in size) located at 2, 5, or 10 m intervals along 4-6 transects in each sampling area. Transects began at the upland edge of the marsh vegetation and ran parallel to the elevational gradient to the lower edge of the marsh vegetation. The size of plots and interval between them depended upon the magnitude of the gradient. On areas having a steep gradient and narrow "bands" or "zones" of vegetation 0.5x0.5 m plots and a short interval were used. Areas having a gentle slope were sampled using 1.0x1.0 m plots at 10 m intervals.

Sampling of marshes with no apparent elevational gradient or zonation of vegetation were sampled as homogenous stands. Plots 1.0x1.0 m in size were located at 10 m intervals along a single transect.

WILDLIFE

BIG GAME

Species included in the category of big game included: elk, mule and black-tailed deer, white-tailed deer, mountain goats, bighorn sheep, pronghorns, black bear, and cougar. Direct observations of animals and the presence of tracks and feces were used to determine the occurrence of each of these species in the study area. Records of these observations included date, location, and type of habitat.

Pellet group counts were made in intensive sampling areas for estimating deer-and elk-days use for the major types of habitat in the study area. Counts were made in fall (July-November) 1974 and spring (April-June) 1975 in conjunction with sampling of small mammals and terrestrial furbearers. Counts were conducted in all sampling areas in fall 1974 and in approximately half of the areas in spring 1975. Pellet groups were counted in circular plots of 1/100 acre (11.8 ft. radius) located at 33 meter intervals along linear transects located within sampling areas. Maximum number of plots in a sampling area was 16.

WATERFOWL

The inventory of waterfowl was conducted March 1974-June 1975. Counts from the air, shoreline, and water were utilized to census resident and migrant waterfowl including swans (*Cygniae*), geese (*Anserinae*), ducks (*Anatinae, Anthyinae,* and *Merginae*), grebes (*Podicipendidae*), and coots (*Rallidae*). Grebes and coots were included because their behavior and habitat requirements are similar to waterfowl.

The inventory was divided into three phases: (1) inventory of resident waterfowl, (2) inventory of migrant waterfowl, and (3) an intensive appraisal of the status of Great Basin Canada geese (*Branta canadensis moffitti*) nesting on Umatilla NWR.

Resident Waterfowl

Nest and brood counts were used to inventory resident waterfowl. Nest counts were conducted only in segments 4-6; brood counts were made in all segments. Nest counts were not feasible in segments 1-3 because of the extensiveness and physical structure of probable waterfowl nesting habitat.

All islands in segments 4-6 were searched for goose and duck nests in late May 1974 and again in 1975. The number of nests, estimated fate of nests, and type of habitat in which each nest was located was noted. Probable duck nesting habitat on the Oregon and Washington shorelines was searched using dogs in June 1974 and 1975. Nesting habitat as used above refers to those vegetative communities which are representative of breeding habitat identified in the literature for species known to nest on the study area.

Migrant Waterfowl

Migrant waterfowl populations were monitored with monthly aerial censuses September 1974-March 1975. Two flights, each covering approximately half the study area, were made each month as near to mid-month as weather permitted. Altitude and speed of the aircraft averaged 200 feet and 90 miles per hour. Flights over the lower half of the study area were scheduled to coincide with high tide in segment 2. In addition to estimating numbers of waterfowl, locations were recorded for the purpose of identifying waterfowl concentration areas.

Our aerial censuses were supplemented with ground survey counts conducted by National Wildlife Refuge and Oregon Department of Fish and Wildlife personnel. To minimize duplication, waterfowl counts for the Lewis and Clark NWR, Columbian White-tailed Deer NWR, Ridgfield NWR, and Umatilla NWR made by refuge personnel and counts for Sauvie Island WMA and The Dalles Pool (Segment 5) made by personnel of Oregon Department of Fish and Wildlife were used for those portions of the study area they included.

Intensive Goose Study

The primary objectives of the goose study at Umatilla NWR were to estimate productivity of the resident population and to identify possible limiting factors to productivity. Field work was done during the spring and summer of 1974 and 1975. All islands and Oregon and Washington shorelines were intensively searched for goose nests. Each nest was monitored throughout the nesting season to determine number of eggs, fate of eggs, and fate of nests. The physical and vegetative characteristics of each nest site was examined using recognized sampling procedures. The location of broods were monitored to determine what areas were used for rearing broods.

AQUATIC FURBEARERS

Aquatic furbearers were defined to include beaver, muskrats, nutria, river otter and mink. These mammals were grouped to facilitate inventorying because all are normally associated with water and the immediate shoreline zone. Methods used to inventory these species included shoreline searches for tracks and sign, trapping, and estimates of harvest.

Shoreline Searches

Searches of shorelines for tracks, other sign (i.e., scat, trails, dens, feeding areas, and territorial marking areas of beaver and otter), and direct observation of animals was the principal method of inventory in all segments of the study area except segments 1 and 2 where trapping was the principal method. Shoreline searches were conducted primarily in late summer and fall when burrows of beaver, muskrats, and nutria and tracks of all species traveling on or crossing the shoreline zone were easily observed

due to low water levels and infrequent rainfall. Less intensive searches were conducted during other seasons. The number of tracks, trails, scats, burrows, feeding areas, and territorial marking areas were recorded by species, segment of study area, and specific location to determine species presence and to estimate in qualitative terms the abundance of each species.

Sampling of shorelines was stratified on the basis of broad classes of vegetation adjacent to the shoreline, land form class if there was no vegetation adjacent to the shoreline, and segment of the study area. Locations where tracks and other sign were easily observed were emphasized in the searches. The number and length of shoreline areas examined varied in each segment.

All areas supporting suitable beaver habitat in segments 1, 4, 5, and 6 were examined for the presence of beaver in order to estimate the total number of "colonies" present. Segments 2 and 3 contained too much potential beaver habitat to be examined in their entirety. The existence of a colony was determined by the presence of recent sign (i.e. trails, cuttings, scent posts, and bank dens or lodges) in an area.

Trapping

Trapping was the principal method used to inventory muskrats, nutria, and mink in segment 1 and 2. Tidal action made shoreline searches for tracks and sign impractical in these segments. Leg-hold and "conibear" killer-type traps were set in trails, entrances to dens, and feeding areas of muskrats and nutria. Traps set in this manner were also suitable for capturing mink.

Trapping effort was stratified on the basis of shoreline vegetative types. The number of muskrats, nutria, and mink captured per trap night in each habitat provided an index of relative abundance. Estimates of density and total numbers of these species were not made.

Estimates of Harvest

Estimates of the number of beaver harvested by licensed trappers from the Columbia River in the 1973-74 and 1974-75 trapping seasons were obtained from unpublished reports of Oregon Department of Fish and Wildlife and Washington Department of Game. Harvest figures were tabulated by county in each state and as a result it was not possible to determine how many beaver were harvested from some segments of our study area because county and segment boundries were not the same. For segments 2 and 3 these boundries were close, and it was in these segments that a total count of colonies was not feasible. The harvest in segments 2 and 3 provided minimum population estimates.

TERRESTRIAL FURBEARERS

Inventory of terrestrial furbearers was done in each intensive sampling area in conjunction with sampling procedures for small mammals using scent stations. Scent stations were established at 200-m intervals along the small mammal transects and usually at least 20 m from the immediate area of the small mammal trap stations. When possible, scent stations were established

near trails or other natural travelways used by carnivores. A 500-m transect consisted of three scent stations. Scent stations were operated 2 consecutive nights during the fall 1974 sampling period and 3 consecutive nights during the spring 1975 sampling period.

Scent stations similar to those used by the U.S. Fish and Wildlife Service for coyote scent station indicies (Linhart and Knowlton 1975) were used when conditions were appropriate for identifying animal tracks. When conditions were not suitable for identifying tracks, a Victor 3N leg-hold trap was placed at each scent station in a manner that an animal would likely step into the trap to approach the scent. Conditions such as rain; strong wind; and too hard, too soft, or lack of soil were considered unsuitable for observing tracks.

Track stations consisted of a wooden stake driven into the center of a 1-m diameter circle which was cleared to expose the soil for track identification. A piece of sheep skin was nailed to the stake and saturated with a commercially prepared (Joseph A. Garcia & Son, Hollister, California), food-based, liquid scent. All identifiable tracks at scent stations were recorded by species. No attempt was made to determine how many individuals of each species visited a scent station. Only one individual of each species was scored as a visit to the scent station. All tracks at a station were destroyed after each night by smoothing the soil.

Each sampling area was searched for the presence of terrestrial furbearer tracks and other sign. Visual sightings, tracks, and other sign recognizable as to species of terrestrial furbearers were recorded in each intensive sampling area. This information supplemented data from scent stations for documenting the occurrence of species.

The sampling methods described above for inventorying terrestrial furbearers produced an index of abundance for each species by habitat, segment of the study area, and season. The indices are in the form of visits per scent station-night. Comparison of these indices between habitats, segments of the study area, and seasons provided information concerning relative abundance for each species of terrestrial furbearers.

BIRDS OTHER THAN WATERFOWL

A total of 78 sampling areas in 26 types of habitat were censused for birds other than waterfowl (Table 4). Scoters and mergansers were included in our censusing efforts. The size of the study area, variety of habitats, and objectives of the study dictated that as many areas as possible be surveyed rather than intensive sampling of a few areas.

Each sampling area used for sampling birds other than waterfowl (Table 4) was surveyed on two successive days during each of four different seasons: Fall (25 September-2 November 1973), Winter (10 January-14 February 1974), Spring (12 April-4 May 1974), and Summer (23 May-18 June 1974). Specific sampling dates for each area and the census technique used are indicated in Table 4.

Table 4. Habitats censused for birds other than waterfowl from 25 August 1973 to 18 June 1974[a]. (N.S. = not sampled)

	Sampling Area No.	No. Stations or Transect Length	Sampling Method	Sampling Dates
Segment 1				
Open Water	26[b]	1,200 M	Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18
Rip-rap--Jetty	27[b]	600 M	Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18
Beach	28[b]	1,000 M	Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18
Beachgrass	1	500 M	Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18
Tidal Marsh	3	500 M	Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18
Alder	4	6	Plotless Circle Count	10/18 1/ 8- 9 5/ 3- 4 6/17-18
Tidal Marsh	2	200 M	Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18
Mud Flat	29[b]		Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18
Raptor Census--Oregon	30[b]	3,800 M	Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18
Raptor Census--Washington	31[b]	21,000 M	Transect	10/15-16 1/ 8- 9 5/ 3- 4 6/17-18

Table 4. (cont.)

	Sampling Area No.	No. Stations or Transect Length	Sampling Method	Sampling Dates
Segment 2				
Sitka Spruce	18	6	Plotless Circle Count	11/ 2 1/12-13 4/22-27 6/11-12
Large Willow	5	6	Plotless Circle Count	11/ 8 1/12-13 4/22-27 6/11-12
Tidal Marsh	16	500 M	Transect	11/ 2 1/12-15 4/22-27 6/11-12
Tidal Marsh	15	500 M	Transect	11/ 2 1/12 4/22-27 6/11-12
Cottonwood	19	8	Plotless Circle Count	11/ 2 1/12-13 4/22-27 6/11-12
Cottonwood/Willow	20	5	Plotless Circle Count	11/ 2 1/12-13 4/22-27 6/11-12
Reed Canarygrass	6	1,000 M	Transect	11/ 2 N.S. N.S. N.S.
Beach	23[b]		Total Count	11/ 2 1/12-13 4/22-27 6/11-12
Open Water	24[b]	4,800 M	Transect	11/ 2 1/12-13 4/22-27 6/11-12
Tidal Shrub Willow	17	6	Plotless Circle Count	11/ 2 2/12 4/22-27 6/11-15

Table 4. (cont.)

	Sampling Area No.	No. Stations or Transect Length	Sampling Method	Sampling Dates
Open Water	25[b]	Variable	Transect	11/ 2 1/12-13 4/22-27 6/13-14
Segment 3				
Large Willow	5	6	Plotless Circle Count	10/29-31 2/13-14 4/27-28 N.S.
Cottonwood	15	7	Plotless Circle Count	10/29-30 2/13-14 4/22-23 6/15-16
Ash/Willow/Cottonwood	7	5	Plotless Circle Count	10/30-31 2/13-14 4/22-24 N S.
Ash/Willow/Cottonwood	3	6	Plotless Circle Count	11/ 5- 6 1/10-11 4/28-29 6/ 9-10
Cottonwood	1	6	Plotless Circle Count	11/ 5- 6 1/10-11 4/28-29 6/ 9-10
Willow/Cottonwood	2	5	Plotless Circle Count	11/ 5- 6 1/10-11 4/28-29 6/15-16
Beach	20[b]	1,000 M	Transect	11/ 5- 6 1/10-11 4/28-29 6/15-16
Open Water	21[b]	1,000 M	Transect	11/ 5- 6 1/10-11 4/28-29 6/15 16
Raptor Census	22[b]	2,000 M	Transect	11/ 5- 6 1/10-11 4/28-29 6/ 9-10

Table 4. (cont.)

	Sampling Area No.	No. Stations or Transect Length	Sampling Method	Sampling Dates
Open Water	23[b]	4,800 M	Transect	10/29-30 2/13-14 4/22-23 6/15-16
Beach	24[b]	2,500 M	Transect	10/29-30 2/13-14 4/22-23 6/15-16
Shrub Willow	17	4	Plotless Circle Count	10/29- 11/ 1 2/13-14 4/22-23 6/15-16
Reed Canarygrass	18	1,000 M	Transect	10/29-30 2/13-14 4/22-23 6/15-16
Segment 4				
Large Willow	2	3	Plotless Circle Count	10/10-12 1/26-27 4/16-17 5/31- 6/ 1
Large Willow	1	4	Plotless Circle Count	10/10-12 1/26-27 4/16-17 5/31- 6/ 1
Marsh	17[b]		Transect	10/ 9-11 1/26-27 4/ 8- 9 5/31- 6/ 1
Beach	18[b]	900 M	Transect	10/ 9-11 1/26-27 4/ 8- 9 5/31- 6/ 1
Rip-rap--Oregon	8	1,000 M	Transect	10/10 1/26-27 4/16-17 5/31- 6/ 1

Table 4. (cont.)

	Sampling Area No.	No. Stations or Transect Length	Sampling Method	Sampling Dates
Grassland	12	1,000 M	Transect	10/10 1/26-27 4/ 8- 9 5/31- 6/ 1
Open Water--Oregon	19[b]	1,000 M	Transect	10/ 9 1/26-27 4/ 8- 9 5/31- 6/ 1
Open Water--Washington	20[b]	500 M	Transect	10/11 1/17-18 4/ 8- 9 5/31- 6/ 1
Large Willow	9[b]	5	Plotless Circle Count	10/ 9-11 1/17-18 4/16-17 5/31- 6/ 1
Shrub Willow	7	8	Plotless Circle Count	10/11 1/17-18 4/16-17 5/31- 6/ 1
Oak	5	6	Plotless Circle Count	10/10-11 1/17-18 4/ 8- 9 5/29-30
Oak/Pine	4	6	Plotless Circle Count	10/10-12 1/17-18 4/16-17 5/29-30
Douglas fir/Maple	3	6	Plotless Circle Count	10/10-12 1/26-27 4/16-17 5/31- 6/ 1
Segment 5				
Shrub Willow	3	4	Plotless Circle Count	10/ 2- 4 1/15-16 4/10-11 5/27-28

Table 4. (cont.)

	Sampling Area No.	No. Stations or Transect Length	Sampling Method	Sampling Dates
Rip-rap	6	1,000 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Rip-rap	7	1,000 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Open Water--Washington	10[b]	1,000 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Rock Cliff/Grassland	2	500 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Rabbitbrush	1	500 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Rip-rap	13[b]	1,000 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Open Water--Oregon	11[b]	1,000 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Open Water	14[b]	1,000 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Raptor Census--Oregon	15[b]	28,000 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Raptor Census--Washington	16[b]	3,100 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Cliff Face--Oregon	17[b]	500 M	Total Count	10/ 2- 4 1/15-16 4/10-11 5/27-28

Table 4. (cont.)

	Sampling Area No.	No. Stations or Transect Length	Sampling Method	Sampling Dates
Cliff Face	18[b]	1,000 M	Total Count	10/ 2- 4 1/15-16 4/10-11 5/27-28
Large Willow	10[b]	6	Plotless Circle Count	10/ 2- 4 1/15-16 4/10-11 5/27-28
Beach	11[b]	1,000 M	Transect	10/ 2- 4 1/15-16 4/10-11 5/27-28
Large Willow	4	9	Plotless Circle Count	10/ 2- 4 1/15-16 4/10-11 5/27-28
Segment 6				
Russian Olive	9	8	Plotless Circle Count	9/25-26 1/30-31 4/12-13 5/23-24
Grassland	6	1,000 M	Transect	9/25-26 1/30-31 4/12-13 5/23-24
Marsh	8		Total Count	9/25-26 1/30-31 4/12-13 5/23-24
Rabbitbrush	5	1,000 M	Transect	9/25-26 1/30-31 4/12-13 5/23-24
Cottonwood/Willow	19	8	Plotless Circle Count	9/27-28 1/28-29 4/14-15 5/25-26
Rabbitbrush	13	1,000 M	Transect	9/27-28 N.S. N.S. N.S.

Table 4. (cont.)

	Sampling Area No.	No. Stations or Transect Length	Sampling Method	Sampling Date
Marsh	15		Transect	9/27-28 1/28-29 4/14-15 5/25-26
Rip-rap	11	1,000 M	Transect	9/27-28 1/28-29 4/14-15 5/25-26
Beach	20[b]	1,000 M	Transect	9/27-28 1/28-29 4/14-15 5/25-26
Sagebrush	18	1,000 M	Transect	9/27-28 1/28-29 4/14-15 5/25-26
Bitterbrush	12	900 M	Transect	N.S. 1/28-29 4/14-15 5/25-26
Open Water	22[b]	5,000 M	Transect	9/27-28 1/28-29 4/14-15 5/25-26
Raptor Census--Oregon	23[b]		Transect	9/25-26 1/30-31 4/12-13 5/23-24
Raptor Census Washington	24[b]		Transect	9/27-28 1/28-29 4/14-15 5/25-26

[a]With the few exceptions indicated, each area was sampled on two successive days during each season.

[b]These areas sampled only for birds; not used otherwise in this study.

Bird inventories of sampling areas were completed within 4 hours after sunrise. Selected groups of birds were sought at other times of the day and night, and incidental observations of all birds were made continually.

Specific sampling methods used in the inventory of birds other than waterfowl are discussed below.

Plotless Circle Count

Sampling stations were established 50-200 meters apart in intensive sampling areas so as to eliminate auditory or visual overlap between stations. Approximately 1-2 minutes after arriving at a station, an observer (occasionally two observers were used in areas with large numbers of birds and tall trees) would begin a 10-minute count in which all birds heard or seen and judged to be utilizing the sampling area being censused were recorded. The initial observational distance was recorded and additional information on behavior, height above ground, foraging activity, and association with other species was recorded for each bird observed whenever possible. Individual birds were counted only once during each 10-minute period. All possible efforts were made to avoid counting a bird twice on the same day.

The area surveyed for each species was calculated on the basis of a mean detection distance for a given type of habitat. This figure was used as the radius of a circular observational area. The area of this circle was then multiplied by the total number of stations censused to give a total area surveyed. Density figures for each species were determined by dividing the area surveyed into the number of birds observed at distances equal to or less than the mean detection distance. A detailed discussion of the characteristics of this sampling technique and its advantages over other census methods is presented by Reynolds, Scott, and Nussbaum (In prep.).

For those species which occurred less than 5 times during a 2-day sampling period, the area surveyed was determined in one of the following fashions:

1) If sufficient observations were available for the same season and similar habitat, or a similar behaving species in the same or similar habitat, that mean detection distance was used as the radius of the circular observational area.

2) When an insufficient number of observations were made, a mean detection distance of 60 feet, or the observed detection distance, whichever was the greatest, was used. However, for hummingbirds a mean detection distance of 100 feet was assumed because of their tendency to approach the observer.

3) For large and/or conspicuous species (e.g., common crow, Steller's jay, great blue heron, etc.) or aggregations of species occurring in small discrete stands of vegetation of known acreages, it was assumed that all birds in the area were counted and density was determined by dividing the total area times the number of observational days into the number of birds observed.

Transects

Rip-rap, beach, open water immediately adjacent to the beach, and vegetated areas with low vertical profiles were sampled using a 500-1,000-m transect marked at 100-m intervals with laths and flagging. Birds were censused by an observer walking slowly (20-30 minutes for 1,000 m) along the transect recording all birds seen and their perpendicular distance from the transect when first observed. The area surveyed was calculated for each species as being the area of a rectangle the length of which was that of the transect and the width twice the mean detection distance. Density figures were determined by dividing all birds of a particular species, observed at a distance equal to or less than the mean detection distance, by the total area surveyed for that species. In the case where fewer than 5 observations were made of a species, it was assumed that the mean sighting distance was 100 feet. For open water areas, the area surveyed was assumed to be 328 feet to either side of the observer. All occurrences of birds observed along rip-rap and beaches were expressed as birds per km, a linear measure. Rip-rap and adjacent open water were censused from the passenger side of a vehicle moving 5-15 m.p.h.

Boat Transects

Open water areas were censused from a boat. All birds observed in a 180° arc from the bow of the boat and their distance at right angles to the vessel's path were recorded. The estimates of densities were observed at in the same fashion as previously prescribed for transects.

Raptor Counts

Raptor counts were conducted by two observers, from a vehicle traveling over an area of known length at speeds of 35 m.p.h. or less (Craighead and Craighead 1956). All Ciconiiformes, Falconiformes, Galliformes, Strigiformes, Laridae, Columbiformes and large Corvidae observed were recorded, with densities figured in the same fashion as previously described for transects, or expressed in terms of birds observed per km of travel.

Owl Census

All owls observed during regular censusing periods were recorded and handled in the same manner as described for other species. In addition, in areas where it was felt that owls might be expected to occur, attempts to call them were made. All calling was done one hour or more after dark. Vocal imitations of the following owls were made: pygmy owl, saw whet owl, screech owl, long-eared owl, and great horned owl. Calls for each species were repeated for 3-5 minutes, starting with the smallest and ending with the largest species. In all but two types of habitat censused, it was determined that all owls within the area could hear and be heard by the observers, and densities were based on the number of owls heard or seen divided by total area of habitat. This will result in an overestimation of abundance where birds are using more than one habitat. Densities for those study areas which

could not be completely surveyed were determined on the basis of the observed distance between calling owls. During the breeding season (January-June), if only one bird responded, it was assumed to be paired. In several instances, densities could not be determined and the birds were simply recorded as occurring in the area.

Rail Census

Vegetative types in which rails might be expected to occur were visited in the evening or early morning hours, and 5-minute recordings of the Virginia rail, sora, yellow rail, and black rail were played. All responses were then recorded and densities figured on the basis of a known area being surveyed.

SMALL MAMMALS

Small mammal populations were inventoried by trapping in intensive sampling areas during two sampling periods. The fall sampling period began 17 August 1974 in segment 1 and was completed 30 November 1974 in segment 6. All 82 intensive sampling areas were inventoried using two consecutive trap-nights during the fall inventory. The spring sampling period was 3 May-15 July 1975. Order of sampling was segment 3 (some sampling areas), 4 (some sampling areas), 5, 6, 1, 2, 3 (some sampling areas), and 4 (some sampling areas). An attempt was made to inventory areas of low elevation before spring high water flooded them; those areas sampled first in segments 3 and 4 were such areas. Fifty-four sampling areas were inventoried during the spring sampling period using three consecutive trap-nights.

Trap stations were established at 33-m intervals along a linear transect within each intensive sampling area. The number of trap stations per sampling area varied according to the size of the area, but with 16 stations (500-m transect) being a maximum. One baited and one unbaited Museum Special snap trap was set at each trap station. In addition, every third station, beginning with station 1, received a baited Victor rat trap; every third station, beginning with station 2, received a baited Sherman live trap; and every third station, beginning with station 3, received an unbaited pitfall (can or cone) trap. Traps were located within a 5-m radius of each station. Additional traps such as 110 and 220 Conibear traps, cinch and Victor gopher traps, and mole traps were used where sign and appropriate conditions occurred.

In forested habitat a baited Museum Special was placed in a tree at every third station beginning with station 2 and a baited Sherman live trap was set in a tree every third station beginning with station 3. The live trap was attached to a wooden platform which was nailed to the tree. The trap's door faced the tree. Thus, each 500-m or 16-station transect in forested areas consisted of 16 unbaited Museum Specials, 16 baited Museum Specials, 6 baited Victor rat traps, 5 Sherman live traps and 5 pitfall traps on the ground, and 5 baited Museum Specials and 5 Sherman live traps in trees.

Baited and unbaited traps were kept separate during transit to avoid getting bait on the unbaited traps. The bait used was a mixture of beef suet, peanut butter, ground raisins, oatmeal and parafin wax (Taber and Cowan 1963). The purpose of this variety of different baits mixed into one was to attract a greater diversity of mammals and simplify the procedure of baiting traps.

The trapping methods described above for inventorying small mammals provided an index of abundance for each species by habitat, segment of the study area, and season. The indices produced are in the form of captures per trap-night. Comparisons of these indices between habitats, segments of the study area, and seasons provided estimates of relative abundance for each species of small mammals. Also, visual sightings, tracks, scat and other sign recognizable as to species of small mammal were recorded in each intensive sampling area. This information was used to supplement data from trapping to document the occurrence of species.

MARINE MAMMALS

The inventory of marine mammals was done in conjunction with aerial waterfowl surveys conducted in June 1974, September 1974-March 1975, and June 1975. Supplemental observations made while conducting inventories of other groups of wildlife also provided information on occurrence and abundance of marine mammals. Harbor seals were the only species of marine mammal expected to occur in the study area. "Haulouts" identified by Pearson (1969) in segment 1 and the lower portion of segment 2 were examined specifically for the presence of harbor seals. In addition, records of sightings of harbor seals and other marine mammals were sought.

BATS

Bat populations were sampled 22 June 1974-19 September 1974. Sampling began in segment 6 and continued downstream to segment 1. Forty-one intensive sampling areas were inventoried during the study. All types of habitat in which intensive sampling areas were established were sampled. Five areas were sampled in segment 1, seven areas in segments 2 and 3, eight areas in segment 4, five areas in segment 5, and nine areas in segment 6. One night of sampling was alloted for each intensive sampling area. The last 2 weeks of the study were spent re-examining intensive sampling areas of special interest and those where few or no bats were observed during the initial sampling. Special effort was also employed within each segment to locate natural and artificial roosts.

Sampling within segment 6 was conducted by "campsite". Each campsite was located near several intensive sampling areas. One mist net was placed in each intensive sampling area. The number of nights of mist-netting in each of these areas was equal to the number of intensive sampling areas at each campsite. The initial time of setting each net for the evening was rotated among intensive sampling areas. The nets were tended on a circuit for a minimum of 4 hours nightly. Nets were left set until

morning. In addition to mist netting, one period of shooting (dusk to dark) was alloted for each intensive sampling area. All bats observed (dusk to dark) near or within sampling areas were also counted and recorded. Bats collected were kept as voucher specimens. Data obtained from each specimen included standard measurements, reproductive condition, internal and external parasites and stomach contents.

Sampling in segments 1-5 was concentrated in a single intensive sampling area per night. One or more nets were set in each area. All nets were set so that no more than 10 minutes elasped between tending the first and last net. Shooting and observation took place within the vicinity of nets. As in segment 6, all bats collected were kept as voucher specimens and the same data were obtained.

Estimates of relative abundance were based on one observation period per intensive sampling area. This period was defined as the interval between sunset and total darkness. All bats observed during this period regardless of species were counted. In those intensive sampling areas where more than one night was spent the total number of bats counted was divided by the number of observation periods.

Mist netting, shooting, and collecting from day and night roosts were methods used to document occurrence within intensive sampling areas and segments of the study area. These methods in addition to estimates of relative abundance were used to determine the species of bats and relative numbers of bats in each intensive sampling location of the study area. This information was then used to predict effects of power peaking on bat populations.

REPTILES AND AMPHIBIANS

The inventory of amphibians and reptiles began 19 April 1974. Before that date, several trips were made to sampling areas in order to gain familiarity with the study area and make preliminary searches. During the spring and summer 1974, 10 trips, ranging from 3 days to 2 weeks in length, were made to the study area to survey amphibian and reptile populations. In October and November 1974, three 2-day trips were made to the study area, with several more such trips made in the spring and summer 1975. Observations were also obtained from sites other than intensive sampling areas.

Methodology for this portion of the wildlife survey emphasized timed searches of the sampling areas, in which the total number of individuals of each species encountered was recorded. This provided species lists and estimates of relative abundance (individuals/species/man-hour). Search effort within the sampling areas was concentrated in those places where animals were most likely to be found. We felt that such a strategy would allow the best assessment of abundance and species occurrence. Visits to the sampling areas were planned so that conditions would be as nearly optimal as possible for finding the greatest number and diversity of animals.

During spring and summer, this dictated that searches be made at a time when temperatures were below the daily peak (i.e., during morning and late afternoon hours). For amphibians, moisture conditions as well as temperature were considered.

Particular methods of search utilized over the study area were dependent to some degree upon the physiography of the sampling areas and upon the types of animals expected. Methods of search can be divided into four general categories: 1) land searches, 2) binocular scans, 3) flush searches, and 4) identification of vocalizations. Land searches consisted of turning over debris (i.e., rocks and boards), tearing apart logs, searching rock crevices, and sifting through moist talus slopes and seeps. This method was used whenever suitable debris, crevices, talus, and/or seeps were present in an area. Binoculars were used to scan for basking reptiles and frogs whenever it was possible to do so. Such scans were made in rock cliff, talus, marsh, and pond areas. Binocular scans were almost always used in conjunction with land or flush searches. Flush searches were carried out primarily in sagebrush, rabbitbrush, bitterbrush, and grassland habitats. In the three former types of habitat, the search consisted of walking an irregular path through the area that conformed to the spacing of the shrubs. The basis for this type of search is that lizards (and to some extent snakes) inhabiting these areas typically bask in the sun a short distance from vegetation cover. By carefully scrutinizing the perimeter of individual shrubs animals startled into movement by the observer can readily be identified, and collected if necessary. In grassland habitat, any discontinuities were given added attention since they would most likely be focal points of activity, providing possible sites for basking and refuge. Identification of vocalizations was of importance in the determining the presence and abundance of the Pacific treefrog, bullfrog, Woodhouse's toad, and the Great Basin spadefoot toad. Listening for calls was usually done during the late afternoon and night, although treefrogs and bullfrogs could often be heard at almost any time of day in mild weather. In addition to the above methods, night-time searches of roads were made (segment 6) and potential amphibian breeding areas were checked for eggs and larvae.

HUMAN USE OF WILDLIFE RESOURCES

Consumptive and non-consumptive uses of wildlife resources (excluding fish) were recorded incidentially while conducting other phases of the study. Personnel involved in inventorying vegetation and wildlife noted the location, date, and specific activity of persons they observed using wildlife resources in the study area. In addition, records of wildlife related human use of the study area kept by state and federal agencies were sought.

EFFECTS OF PEAKING

Preliminary effects of power peaking operations on wildlife populations and wildlife habitat was estimated by identifying those species or populations of animals and vegetative communities that occur in portions of the study area likely to be within the zone of fluctuation of water levels due to peaking

operations. The estimates were very general in nature in most cases however because of the lack of specific information concerning where, when, and how much that water will fluctuate as a result of regulation for power peaking. In addition to identifying those animals that utilize shoreline habitat of low elevation, the time of year that changes in water levels would be most critical to those populations were identified on the basis of each species' natural history and information on seasonal use of certain habitats obtained in this study.

Our assessment of the impact of peaking on wildlife and habitat was made only for that portion of the study area from RM 105 (Portland) to RM 292 (McNary Dam). Changes in water levels due to peaking operations are predicted to be minimal downstream from RM 105.

VI. RESULTS AND DISCUSSION

VEGETATIVE TYPES AND LAND FORM CLASSES

Vegetative types and land form classes identified within the study area are delineated on aerial photo mosaics that are in Appendix A. The legend describing the code numbers used to designate vegetative types and land form classes that appear on the aerial photo mosaics is Appendix B.

Estimates of acreage for each vegetative type and land form class identified in each segment of the study area are presented in Tables 5-10. Estimates of miles of shoreline for vegetative types and land form classes immediately adjacent to the river shore in segments 4, 5 and 6 are presented in Tables 11-13.

An overall view of the vegetative composition and terrain of the study area is presented below. This qualitative description of the study area represents somewhat of a summary of the information contained on the aerial photo mosaics (Appendix A) and also contains additional information which could not be shown on the photographs. Marsh vegetation of islands in the lower portion of segment 2 is discussed in considerable detail because a review of available literature indicated that these extensive marsh communities have received very little if any study.

The types of habitat (vegetative types and land form classes) in which intensive sampling areas were established in each segment of the study area and the number of sampling areas established in each is shown in Table 14. Eighty-two sampling areas were established in 21 different vegetative and 2 land form types. The exact location,physical characteristics and vegetative community of each of these intensive sampling areas is discussed. Photographs of each sampling area are contained in Appendix C. All sampling areas are listed in Table 15.

A list of plant species (common and scientific names) identified in the study area during this study is presented in Table 16.

Table 5. Estimates of acreage for vegetative types and land form classes identified in Segment 1.

Vegetative Types and Land Form Classes	Number of Acres
Tidal marsh	1,067.15
Beachgrass	897.59
Sand	557.62
Grassland	544.12
Residential	507.85
Alder	494.35
Pasture	422.67
Industrial	280.08
Douglas fir / Sitka spruce / alder	229.46
Alder / Sitka spruce	214.27
Willow / alder	193.18
Shrub willow	121.48
Beachgrass / sedge meadow	116.42
Airport	90.27
Developed parks or campgrounds	50.62
Shrubs / beachgrass	44.71
Willow, large trees	37.12
Willow, small trees	36.27
Marsh	32.90
Ponds, lakes, and reservoirs	31.21
Grassland / sedge meadow	26.15
Pond	13.50
Shrubs	10.97
Rock rip-rap	10.12
Urban lands	10.12
Sitka spruce / western red cedar / alder	6.75
Sedge meadows	5.91
Total acres	6,052.86

Table 6. Estimates of acreage for vegetative types and land form classes identified in Segment 2.

Vegetative Types and Land Form Classes	Number of Acres
Tidal marsh	6,580.10
Shrub willow	2,542.24
Willow / cottonwood, large trees	1,930.55
Grassland	1,591.60
Cottonwood, large trees	1,423.67
Willow, large trees	1,095.16
Sitka spruce / western red cedar / cottonwood / alder	1,082.34
Willow, small trees	506.17
Sitka spruce / cottonwood / willow	344.86
Willow / ash	337.88
Cottonwood / ash	333.13
Sitka spruce	256.15
Douglas fir / alder / maple	255.63
Maple / Douglas fir	220.27
Alder / Douglas fir	199.60
Cottonwood / Sitka spruce	124.59
Herbaceous types	119.6
Willow / cottonwood / ash	114.62
Alder	83.97
Willow / alder	78.06
Cottonwood / willow / alder	73.76
Cottonwood, small trees	65.72
Blackberry	61.80
Douglas fir / western red cedar / alder	61.80
Douglas fir	55.07
Ash	46.09
Cottonwood	44.85
Douglas fir / oak / maple	33.89
Willow / cottonwood	28.90
Cottonwood	27.91
Oak / Douglas fir	22.92
Shrub types	20.25
Douglas fir / western red cedar / maple	12.96
Alder / Sitka spruce	9.97
Oak / maple	3.37
Lodgepole pine	2.99
Total acres	19,792.41

Table 7. Estimates of acreage for vegetative types and land form classes identified in Segment 3.

Vegetative Types and Land Form Classes	Number of Acres
Cottonwood, large trees	4,016.55
Grassland	2,844.58
Willow / cottonwood, large trees	1,492.94
Willow / cottonwood / ash	1,109.33
Willow, large trees	973.78
Cottonwood / ash	882.19
Shrub willow	701.59
Maple / Douglas fir	550.18
Willow / ash	385.72
Willow, small trees	299.85
Marsh	222.26
Herbaceous types	138.54
Grass marsh	124.59
Cottonwood / oak / ash	101.66
Ash	100.67
Oak	69.77
Douglas fir / ash / maple	49.84
Cottonwood / oak	35.88
Maple / alder	31.89
Blackberry	28.90
Douglas fir	27.66
Douglas fir / cottonwood	20.93
Willow / cottonwood, small trees	8.97
Cottonwood, small trees	5.98
Sedge marsh	5.98
Oak / Douglas fir	3.99
Oak / ash	1.99
Total acres	14,236.21

Table 8. Estimates of acreage for vegetative types and land form classes identified in Segment 4.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Pasture	619.13	140.54	11.94	771.61
Grassland	417.96	299.46	24.80	742.22
Industrial	533.70	206.68	--	740.38
Oak / Ponderosa pine	249.85	223.21	--	473.06
Residential	366.52	77.16	--	443.68
Oak	146.97	80.83	0.91	228.71
Maple / Douglas fir	186.47	93.69	--	280.16
Willow, large trees	189.23	37.66	24.80	251.69
Herbaceous types	139.62	40.41	--	180.03
Willow, small trees	127.68	9.18	2.75	139.61
Field crops	--	121.25	--	121.25
Douglas fir	40.41	77.16	--	117.57
Grassland / herbaceous types	101.96	--	--	101.96
Oak / Douglas fir	30.31	56.95	--	87.26
Cottonwood / large trees	30.31	25.72	2.75	58.78
Broadleafed tree over herb layer	32.15	14.69	--	46.84
Ponderosa pine / Douglas fir / oak	--	45.93	--	45.93
Developed parks or campgrounds	43.17	--	--	43.17
Shrub willow	31.23	9.18	--	40.41
Tree, shrub, vine crops	35.82	--	--	35.82
Mixed broadleaf and coniferous tree over herb layer	11.02	13.77	--	24.79
Maple / alder	20.20	--	--	20.20
Douglas fir / ash / maple	--	19.29	--	19.29
Oak / ash	9.18	8.26	--	17.44
Willow / ash	12.86	3.67	--	16.53
Willow / cottonwood, small trees	15.61	--	--	15.61
Broadleafed tree over herb layer	--	14.69	--	14.69
Alder	--	14.68	--	14.68
Willow / cottonwood / ash	13.77	--	--	13.77
Rocklands	--	13.77	--	13.77
Sand and gravel	12.86	--	--	12.86
Ponderosa pine / oak / maple	--	11.02	--	11.02
Grass marsh	8.26	2.75	--	11.01
Grass meadow	8.26	2.75	--	11.01
Transportation, communications, and utilities	--	10.10	--	10.10
Ponderosa pine	1.83	8.26	--	10.09
Willow / cottonwood, large trees	9.18	--	--	9.18
Cottonwood / ash	--	7.34	--	7.34
Willow	--	7.34	--	7.34
Maple	--	5.51	--	5.51
Cat-tail marsh	--	3.67	--	3.67
Marsh	--	3.67	--	3.67

Table 8. Continued.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Cottonwood / ash / maple	--	2.75	--	2.75
Coniferous tree over herb layer	--	1.83	--	1.83
Urban and resource extraction	1.83	--	--	1.83
Broadleaf forest	1.83	--	--	1.83
Coniferous forest	0.91	--	--	0.91
Total acres	3,450.09	1,714.82	67.95	5,232.86
Embayments	777.13	144.22	--	632.91

Table 9. Estimates of acreage for vegetative types and land form classes identified in Segment 5.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Grassland	91.1	249.3	632.7	964.1
Rock / grassland	334.3	123.1	--	478.8
Rabbitbrush	99.6	139.7	--	239.3
Pasture	25.5	112.7	85.7	223.9
Rabbitbrush / grassland	154.4	40.1	--	194.5
Herbaceous types	153.6	10.8	--	164.4
Agricultural production	--	136.7	--	136.7
Shrub willow	97.3	24.7	2.3	124.3
Gravel / herbaceous types	--	123.1	--	123.1
Residential	94.2	4.6	--	98.8
Industrial	29.3	51.4	--	80.8
Developed parks or campgrounds	14.7	42.5	--	57.1
Herbaceous types / grassland	--	38.6	--	38.6
Willow, large trees	35.2	0.8	--	36.0
Sagebrush / rabbitbrush types	27.8	--	--	27.8
Willow, small trees	--	--	23.9	23.9
Herbaceous types / marsh	20.8	--	--	20.8
Tree, shrub, vine crops	--	20.8	--	20.8
Bitterbrush / sagebrush	--	18.5	--	18.5
Marsh	10.8	7.0	--	17.8
Field crops	--	17.8	--	17.8
Sand and gravel	--	--	16.2	16.2
White poplar	--	15.4	--	15.4
Rabbitbrush / herbaceous types	14.7	--	--	14.7
Rock rip-rap / grassland	13.9	--	--	13.9
Aquatic vegetation	13.1	--	--	13.1
Rock rip-rap / shrub steppe	12.4	--	--	12.4
Locust / tree-of-heaven	10.8	--	--	10.8
Elm	10.8	--	--	10.8
Rabbitbrush / bitterbrush	--	6.2	--	6.2
Undifferentiated broadleafed trees	6.2	--	--	6.2
Locust	5.4	--	--	5.4
Sagebrush	--	--	4.6	4.6
Tree-of-heaven	--	3.9	--	3.9
Rush meadow	3.1	--	--	3.1
Broadleaf forest	1.5	1.5	--	3.0
Alder	--	2.3	0.8	3.1
Cat-tail marsh	2.3	--	--	2.3
Shrub types	--	2.3	--	2.3
Cottonwood, small trees	--	2.3	--	2.3
Willow / alder	2.3	--	--	2.3
Shrub steppe	1.5	--	--	1.5
Total acres	1,427.9	1,254.6	752.2	3,439.7
Embayments	143.6	37.1	--	180.6

Table 10. Estimates of acreage for vegetative types and land form classes identified in Segment 6.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Rabbitbrush	5,012.8	4,899.8	6.4	9,919.0
Rabbitbrush / sagebrush	175.5	2,703.4	--	2,878.9
Field crops	1,168.5	1,195.1	--	2,363.6
Rock / grassland	1,440.4	346.3	--	1,786.7
Grassland	895.6	608.1	--	1,503.7
Grassland / rabbitbrush	865.3	622.8	--	1,488.1
Sagebrush	547.4	381.2	138.7	1,067.3
Bitterbrush	306.8	618.2	--	925.0
Sand	--	--	865.3	865.3
Herbaceous types	212.2	455.6	--	667.8
Rabbitbrush / bitterbrush	485.0	144.2	--	629.2
Residential	406.0	203.9	--	609.9
Pasture	375.7	161.7	--	537.4
Gravel / herbaceous types	--	370.2	--	370.2
Willow / cottonwood, small trees	49.6	174.5	45.9	270.0
Grass meadow / rabbitbrush	239.8	--	--	239.8
Rabbitbrush / bitterbrush / grassland	222.3	--	--	222.3
Russian olive	216.8	--	--	216.8
Grassland / sagebrush	--	208.5	--	208.5
Shrub steppe	93.7	107.5	--	201.2
Rock / rabbitbrush	--	165.3	--	165.3
Cat-tail / grass marsh	97.4	21.1	--	118.5
Meadow	113.0	--	--	113.0
Marsh	98.3	11.0	--	109.3
Grassland	49.6	51.4	--	101.0
Sagebrush / bitterbrush	--	--	98.2	98.2
Industrial	97.4	--	--	97.4
Mud	--	--	94.6	94.6
Developed parks and campgrounds	65.2	10.1	--	75.3
Forest and woodland types	58.8	--	--	58.8
Gravel / rabbitbrush	--	49.6	--	49.6
Sand / herbaceous types	45.0	--	--	45.0
Sedge / grass marsh	42.3	--	--	42.3
Marsh / sagebrush	42.3	--	--	42.3
Locust	21.1	19.3	--	40.4
Rabbitbrush / bitterbrush / sagebrush	--	36.7	--	36.7
Cat-tail marsh	23.9	8.3	--	32.2
Gravel	--	--	30.3	30.3
Cottonwood, large trees	4.6	23.0	--	27.6
Gravel pit	--	23.9	--	23.9
Pasture / field crops	23.0	--	--	23.0
Tree, shrub, vine crops	--	23.0	--	23.0
Rabbitbrush / meadow	20.2	--	--	20.2
Shrub willow	16.5	2.8	--	19.3
Cat-tail marsh / herbaceous types	--	18.3	--	18.3

Table 10. Continued.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Willow / cottonwood, large trees	14.7	--	--	14.7
Sedge marsh	7.3	6.4	--	13.7
Grass meadow	8.3	--	--	8.3
Willow, small trees	8.3	--	--	8.3
Willow / cat-tail marsh	5.5	--	--	5.5
Broadleaf forest	--	5.5	--	5.5
Coniferous forest	3.7	--	--	3.7
Willow, large trees	--	2.8	--	2.8
Rock rip-rap	--	--	2.8	2.8
Tree-of-heaven	--	2.8	--	2.8
Rock	--	--	1.8	1.8
Total acreage in all habitats	13,579.8	13,682.3	1,284.0	28,546.1
Embayments	30.3	81.8	--	112.1

Table 11. Estimates of miles of shoreline for vegetative types and land form classes immediately adjacent to the river shore in Segment 4.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Rock rip-rap	22.73	26.73	0	49.46
Grassland, undifferentiated	8.24	6.33	1.93	16.50
Willow, large trees	6.14	2.54	0.68	9.36
Industrial	2.43	4.71	0	7.14
Oak / Ponderosa pine	3.48	3.37	0	6.85
Rock	0.25	1.75	4.55	6.55
Willow, small trees	4.92	0.45	0.49	5.86
Oak	1.78	2.99	0	4.77
Pasture	1.86	2.80	0	4.66
Gravel	3.06	1.21	0	4.27
Sand	2.14	1.86	0.15	4.15
Herbaceous types, undifferentiated	2.08	1.31	0	3.39
Cottonwood, large trees	1.33	1.33	0	2.66
Residential	0.68	1.29	0	1.97
Oak / Douglas fir	0	1.71	0	1.71
Herbaceous types / grassland	1.17	0.45	0	1.62
Maple / Douglas fir	0.57	1.02	0	1.59
Developed parks or campgrounds	0.38	0	0.83	1.21
Douglas fir / ash / maple	0	0.95	0.23	1.18
Oak / ash	0.15	0.38	0.49	1.02
Mixed broadleaf and coniferous trees	0.68	0.19	0	0.87
Shrub willow	0.44	0.42	0	0.86
Willow / cottonwood / ash	0.83	0	0	0.83
Douglas fir	0.61	0.15	0	0.76
Broadleaf tree	0.68	0	0	0.68
Ponderosa pine / Douglas fir / oak	0	0.57	0	0.57
Alder / Douglas fir	0.49	0	0	0.49
Willow, large trees / cottonwood	0.19	0	0.19	0.38
Ponderosa pine/ oak / maple	0	0.34	0	0.34
Willow, small trees / cottonwood	0.30	0	0	0.30
Ponderosa pine	0	0.30	0	0.30
Willow / ash	0.15	0.08	0	0.23
Four species mixture (trees)	0.23	0	0	0.23
Coniferous tree	0.19	0	0	0.19
Alder	0	0.19	0	0.19
Douglas fir / alder / maple	0.19	0	0	0.19
Transportation, communications, utilities	0	0.19	0	0.19
Marshes	0	0.15	0	0.15
Ash	0	0.15	0	0.15
Cottonwood / ash	0	0.15	0	0.15
Cottonwood / ash / maple	0.11	0	0	0.11
Grass marsh	0	0.08	0	0.08

Table 11. Continued.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Willow / cottonwood	0.04	0	0	0.04
	68.52	66.14	9.54	144.20

Table 12. Estimates of miles of shoreline for vegetative types and land form classes immediately adjacent to the river shore in Segment 5.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Rock rip-rap	19.63	10.79	0	30.42
Gravel	5.80	3.04	2.15	10.99
Rock	2.13	1.94	2.21	6.46
Sand	0.52	4.02	1.76	6.30
Shrub willow	2.22	0.66	0.49	3.37
Grassland, undifferentiated	0	2.17	0.28	2.45
Cheatgrass / Sandberg's blue-grass / annual fescue	0	2.09	0.14	2.23
Mud	0.24	0	1.43	1.67
Willow / alder	0.14	0.27	0.85	1.26
Willow, large trees	1.25	0	0	1.25
Mullein / biscuit root	0	0.93	0	0.93
Cheatgrass / Sandberg's blue-grass / bulbous bluegrass	0	0.89	0	0.89
Cheatgrass / Sandberg's bluegrass	0	0.87	0	0.87
Sand and gravel extraction operations	0	0	0.81	0.81
Industrial	0	0.78	0	0.78
Russian thistle	0.64	0	0	0.64
Mullein	0.51	0	0	0.51
Gray rabbitbrush	0	0.49	0	0.49
Clover / goldenrod	0.48	0	0	0.48
Rock / cheatgrass / Sandberg's bluegrass	0	0.45	0	0.45
Big sagebrush	0	0	0.43	0.43
Cheatgrass	0.35	0	0	0.35
Gray rabbitbrush / antelope bitterbrush	0	0.33	0	0.33
Buckwheat / cheatgrass	0	0.33	0	0.33
Gray rabbitbrush / cheatgrass / Sandberg's bluegrass	0	0.31	0	0.31
Annual forbs / cheatgrass	0.27	0	0	0.27
Alder	0	0.16	0.09	0.25
Antelope bitterbrush / buckwheat	0	0.22	0	0.22
Goldenrod / cheatgrass	0.18	0	0	0.18
Gray rabbitbrush / buckwheat	0	0.14	0	0.14
Antelope bitterbrush	0	0	0.12	0.12
	34.36	30.88	10.76	76.18

Table 13. Estimates of miles of shoreline for vegetative types and land form classes immediately adjacent to the river shore in Segment 6.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Sand	40.42	33.41	53.26	127.09
Rock rip-rap	36.40	29.92	1.29	67.61
Gravel	8.22	28.90	3.03	40.15
Rock	9.39	11.48	2.05	22.92
Mud	1.78	2.01	5.76	9.55
Smartweed	0	8.64	0	8.64
Gray and green rabbitbrush (mixed)	0.30	3.83	0.04	4.17
Gray rabbitbrush	2.50	1.52	0	4.02
Marsh, undifferentiated	3.30	0.34	0	3.64
Big sagebrush	1.82	1.48	0.11	3.41
Cat-tail / grass marsh	2.54	0	0	2.54
Gravel / herbaceous types	0	1.89	0	1.89
Cheatgrass / Sandberg's bluegrass / bluebunch wheatgrass	0.19	1.44	0	1.63
Gray rabbitbrush / antelope bitterbrush	1.48	0	0	1.48
Cheatgrass	0	1.33	0	1.33
Antelope bitterbrush	0.27	1.06	0	1.33
Sedge marsh	0.76	0.42	0	1.18
Cat-tail marsh	0	1.17	0	1.17
Cheatgrass / bluebunch wheatgrass	0	1.10	0	1.10
Cheatgrass / bluebunch wheatgrass / big sagebrush	0	0	1.10	1.10
Sedge / grass marsh	1.10	0	0	1.10
Herbaceous types	0.53	0.45	0	0.98
Shrub willow	0.98	0	0	0.98
Roads	0.98	0	0	0.98
Rock / cheatgrass / Sandberg's bluegrass / bluebunch wheatgrass / buckwheat	0.95	0	0	0.95
Residential	0	0.87	0	0.87
Gray rabbitbrush / big sagebrush	0.83	0	0	0.83
Russian olive	0.83	0	0	0.83
Grass meadow / gray and green rabbitbrush (mixed)	0.83	0	0	0.83
Field crops	0	0.80	0	0.80
Three-tip sagebrush	0.45	0.19	0	0.64
Cheatgrass / Sandberg's bluegrass	0	0.53	0	0.53
Forbs/Russian thistle	0	0.49	0	0.49
Grassland, undifferentiated	0.15	0.34	0	0.49
Cheatgrass / Sandberg's bluegrass / bluebunch wheatgrass / green rabbitbrush	0	0.49	0	0.49
Cheatgrass / gray rabbitbrush	0.45	0	0	0.45
Developed parks or campgrounds	0	0.45	0	0.45

Table 13. Continued.

Vegetative Types and Land Form Classes	Oregon	Washington	Islands	Total
Mullein / dock	0	0	0.42	0.42
Big sagebrush / gray rabbitbrush	0.30	0	0	0.30
Big sagebrush / antelope bitterbrush	0.19	0	0.11	0.30
Cheatgrass / gray and green rabbitbrush	0.27	0	0	0.27
Meadow, undifferentiated	0.27	0	0	0.27
Willow / cottonwood, large trees	0.04	0	0.23	0.27
Rock / cheatgrass / Sandberg's bluegrass / green rabbitbrush	0	0.23	0	0.23
Perennial forbs	0.23	0	0	0.23
Gray rabbitbrush / green rabbitbrush / big sagebrush	0	0.23	0	0.23
Willow, large trees	0	0	0.23	0.23
Forbs, undifferentiated	0.19	0	0	0.19
Grassland, undifferentiated / antelope bitterbrush	0	0.19	0	0.19
Cat-tail marsh / willow	0.19	0	0	0.19
Dock	0	0.15	0	0.15
Cheatgrass / bulbous bluegrass / gray rabbitbrush	0.15	0	0	0.15
Shrub land, undifferentiated	0	0	0.15	0.15
Green rabbitbrush	0.15	0	0	0.15
Sagebrush	0	0.15	0	0.15
Willow, small trees	0.15	0	0	0.15
Cottonwood, large trees	0.15	0	0	0.15
Willow / cottonwood, small trees	0.15	0	0	0.15
Pasture	0.15	0	0	0.15
Grassland, undifferentiated / big sagebrush	0.11	0	0	0.11
Bluebunch wheatgrass / Sandberg's bluegrass / big sagebrush	0	0.11	0	0.11
	120.14	135.61	67.78	323.53

Table 14. Types of habitat in which intensive sampling areas were established.

Study Area Segment	Habitat	Number of Sampling Areas
1	Beachgrass	2
	Tidal marsh	3
	Alder	2
2	Tidal marsh	4
	Shrub willow, tidal	2
	Sitka spruce	3
	Large willow	1
	Cottonwood	2
	Cottonwood / willow	2
	Reed canarygrass	2
3	Shrub willow	3
	Large willow	3
	Cottonwood	3
	Cottonwood / willow	3
	Willow / cottonwood / ash	3
	Reed canarygrass	3
4	Shrub willow	1
	Large willow	4
	Oak	2
	Oak / ponderosa pine	2
	Douglas fir / maple	2
	Grassland	2
	Rock rip-rap	2
5	Shrub willow	2
	Rabbitbrush	2
	Grassland	2
	Rock rip-rap	2
6	Cottonwood / willow	2
	Marsh	2
	Russian olive	1
	Rabbitbrush	2
	Bitterbrush	2
	Sagebrush	2
	Grassland	4
	Talus	2
	Rock rip-rap	1
Total		82

Table 15. Intensive sampling areas established in the study area.

Sampling Area No.	Segment	Shore	Habitat	Location	Elevation
1	1	Oregon	Beachgrass	RM 5, E. ½, S. 35, T. 8 N., R. 11 W.	Near sea level
2	1	Oregon	Tidal marsh	RM 7, N.W. ¼, S. 6, T. 8 N., R. 10 W.	Intertidal
3	1	Oregon	Tidal marsh	RM 7, N.W. ¼, S. 6, T. 8 N., R. 10 W.	Intertidal
4	1	Oregon	Alder	RM 7, W. ½, S. 6, T. 8 N., R. 10 W.	Near sea level
5	1	Washington	Beachgrass		Near sea level
6	1	Washington	Alder		Near sea level
7	1	Washington	Tidal marsh		Intertidal
1	2	Oregon	Tidal marsh	RM 21, N.E. ¼, S. 20 & S.W. ¼, S. 16, T. 8 N., R. 8 W.	Intertidal
2	2	Oregon	Tidal shrub willow	RM 25, S.E. ¼, S. 12, T. 8 N., R. 8 W.	Intertidal
3	2	Oregon	Sitka spruce	RM 26, N.E. ¼, S. 18, T. 8 N., R. 7 W.	Intertidal
4	2	Oregon	Cottonwood	RM 65, N.E. ¼, S. 7, T. 7 N., R. 2 W.	15-27 ft.
5	2	Oregon	Willow, large	RM 71, S.E. ¼, S. 26, T. 7 N., R. 2 W.	5-10 ft.
6	2	Oregon	Reed canarygrass	RM 75, E. ½, S. 13, T. 6 N., R. 2 W.	> 15 ft.
7	2	Oregon	Willow/cottonwood	RM 74, N.W. ¼, S. 12, T. 6 N., R. 2 W.	10-15 ft.
8	2	Washington	Tidal marsh	RM 23, W. ½, S. 4, T. 9 N., R. 8 W.	Intertidal
9	2	Washington	Sitka spruce	RM 37, N.W. ¼, S. 35, T. 9 N., R. 6 W.	Intertidal
15	2	Island	Tidal marsh	RM 30, W. ½, S. 24, T. 9 N., R. 7 W.	Intertidal
16	2	Island	Tidal marsh	RM 32, N.W. ¼, S. 19, T. 9 N., R. 6 W.	Intertidal

Table 15. Continued.

Sampling Area No.	Segment	Shore	Habitat	Location	Elevation
17	2	Island	Tidal shrub willow	RM 32, N. ½, S. 19, T. 9 N., R. 6 W.	Intertidal
18	2	Island	Sitka spruce	RM 36, S.W. ¼, S. 24, T. 9 N., R. 6 W.	Intertidal
19	2	Island	Cottonwood	RM 74, S.W. ¼, S. 7, T. 6 N., R. 1 W.	10-15 ft.
20	2	Island	Willow/cottonwood	RM 75, S.W. ¼, S. 7, T. 6 N., R. 1 W.	10-20 ft.
22	2	Island	Reed canarygrass	RM 75, N.W. ¼, S. 18, T. 6 N., R. 1 W.	5-10 ft.
1	3	Oregon	Cottonwood, grazed	RM 89, W. ½, S. 22, T. 4 N., R. 1 W.	13-17 ft.
2	3	Oregon	Willow/cottonwood	RM 91, N.E. ¼, S. 34, T. 4 N., R. 1 W.	10-15 ft.
3	3	Oregon	Ash/willow/cotton-wood, grazed	RM 91, N. ½, S. 34, T. 4 N., R. 1 W.	10-15 ft.
4	3	Oregon	Reed canarygrass	RM 97, N.W. ¼, S. 26, T. 3 N., R. 1 W.	15-20 ft.
5	3	Oregon	Willow, large	RM 130, S.W. ¼, S. 21, T. 1 N., R. 1 E.	
6	3	Oregon	Shrub willow	RM 130, S. ½, S. 20, T. 1 N., R. 1 E.	
7	3	Oregon	Ash/willow/cotton-wood, ungrazed	RM 130, N.E. ¼, S. 29, T. 1 N., R. 5 E.	
9	3	Washington	Cottonwood	RM 120, N. ½, S. 14, T. 1 N., R. 3 E.	25-30 ft.
10	3	Washington	Willow/cottonwood	RM 123, S.E. ¼, S. 17, T. 1 N., R. 4 E.	24-30 ft.
11	3	Washington	Ash/willow/ cottonwood	RM 91, N.W. ¼, S. 35, T. 4 N., R. 1 W.	10-15 ft.
12	3	Washington	Willow, large	RM 90, S.W. ¼, S. 26, T. 4 N., R. 1 W.	10-14 ft.
13	3	Washington	Shrub willow	RM 123, S.E. ¼, S. 17, T. 1 N., R. 4 E.	19-20 ft.

Table 15. Continued.

Sampling Area No.	Segment	Shore	Habitat	Location	Elevation
14	3	Washington	Reed canarygrass	RM 123, S.E. ¼, S. 17, T. 1 N., R. 4 E.	22.4 ft.
15	3	Island	Cottonwood	RM 125, S. ½, S. 21, T. 1 N., R. 4 E.	22-24 ft.
16	3	Island	Willow, large	RM 125, N.E. ¼, S. 21, T. 1 N., R. 4 E.	20-22 ft.
17	3	Island	Shrub willow	RM 125, N.E. ¼, S. 21, T. 1 N., R. 4 E.	18-20 ft.
18	3	Island	Reed canarygrass	RM 126, W. ½, S. 22, T. 1 N., R. 4 E.	21-26 ft.
19	3	Island	Willow/cottonwood	RM 124, N.W. ¼, S. 20, T. 1 N., R. 4 E.	
1	4	Oregon	Willow, large (river shore)	RM 161, N.E. ¼, S. 34, T. 3 N., R. 9 E.	78.0-78.3 ft.
2	4	Oregon	Willow, large (embayment)	RM 161, N.W. ¼, S. 35, T. 3 N., R. 9 E.	77-79 ft.
3	4	Oregon	Douglas fir/ maple	RM 161, S.W. ¼, S. 35, T. 3 N., R. 9 E.	150-400 ft.
4	4	Oregon	Oak/Ponderosa pine	RM 177, S.W. ¼, S. 32, T. 3 N., R. 12 E.	90-200 ft.
5	4	Oregon	Oak	RM 178, S.W. ¼, S. 33, T. 3 N., R. 12 E.	100-200 ft.
6	4	Oregon	Grassland	RM 178, S.W. ¼, S. 33, T. 3 N., R. 12 E.	220-240 ft.
7	4	Oregon	Shrub willow	RM 179, S.E. ¼, S. 33, T. 3 N., R. 12 E.	76-82 ft.
8	4	Oregon	Rip-rap	RM 180, S.W. ¼, S. 34, T. 3 N., R. 12 E.	95 ft. at top
10	4	Washington	Oak	RM 162, N. ½, S. 26, T. 3 N., R. 9 E.	80-100 ft.
11	4	Washington	Douglas fir/ maple	RM 162, N.W. ¼, S. 26, T. 3 N., R. 9 E.	160-400 ft.

Table 15. Continued.

Sampling Area No.	Segment	Shore	Habitat	Location	Elevation
12	4	Washington	Grassland	RM 178, N. ¼, S. 32, T. 3 N., R. 12 E.	120-200 ft.
13	4	Washington	Oak/Ponderosa pine	RM 176, S.W. ¼, S. 25, T. 3 N., R. 11 E.	120-320 ft.
14	4	Washington	Willow, large (embayment)	RM 179, N. ½, S. 33, T. 3 N., R. 12 E.	75-90 ft.
15	4	Washington	Willow, large (river shore)	RM 183, N.W. ¼, S. 7, T. 2 N., R. 13 E.	78-83 ft.
16	4	Washington	Rip-rap	RM 177, N. ¼, S. 36, T. 3 N., R. 11 E.	100 ft. at top
1	5	Oregon	Rabbitbrush	RM 198, N.E. ¼, S. 24, T. 2 N., R. 14 E.	~400 ft.
2	5	Oregon	Rock cliff/grass-land	RM 203, N.W. ¼, S. 22, T. 2 N., R. 15 E.	260-300 ft.
3	5	Oregon	Shrub willow	RM 210, S.E. ¼, S. 2, T. 2 N., R. 16 E.	
4	5	Oregon	Willow, large (embayment)	RM 211, S.W. ¼, S. 1, T. 2 N., R. 16 E.	
6	5	Oregon	Rip-rap	RM 208, N. ½, S. 9, T. 2 N., R. 16 E.	~200 ft.
7	5	Washington	Rip-rap	RM 207, N.W. ¼, S. 7, T. 2 N., R. 16 E.	~200 ft.
8	5	Washington	Rabbitbrush	RM 210, E. ½, S. 35, T. 3 N., R. 16 E.	
9	5	Washington	Rock cliff/grass-land	RM 211, N.W. ¼, S. 36, T. 3 N., R. 16 E.	
1	6	Oregon	Talus	RM 222, N.W. ¼, S. 21, T. 3 N., R. 18 E.	400-600 ft.
2	6	Oregon	Rock cliff/grass-land	RM 227, N.W. ¼, S. 6, T. 3 N., R. 19 E.	600-800 ft.
3	6	Oregon	Sagebrush	RM 227, N.E. ¼, S. 6, T. 2 N., R. 19 E.	300-450 ft.

Table 15. Continued.

Sampling Area No.	Segment	Shore	Habitat	Location	Elevation
4	6	Oregon	Bitterbrush	RM 273, N.W. ¼, S. 31, T. 5 N., R. 26 E.	
5	6	Oregon	Rabbitbrush	RM 274, N.W. ¼, S. 31, T. 5 N., R. 26 E.	280-290 ft.
6	6	Oregon	Grassland	RM 276, N. ¼, S. 20, T. 5 N., R. 26 E.	275-285 ft.
7	6	Oregon	Willow/cottonwood	RM 275, S.E. ¼, S. 19, T. 5 N., R. 26 E.	~265-270 ft.
8	6	Oregon	Marsh	RM 276, N.E. ¼, S. 29, T. 5 N., R. 26 E.	~263-268 ft.
9	6	Oregon	Russian olive	RM 279, N.W. ¼, S. 22, T. 5 N., R. 26 E.	280 ft.
11	6	Washington	Rip-rap	RM 283, N. ½, S. 17, T. 5 N., R. 27 E.	275 ft.
12	6	Washington	Bitterbrush	RM 281, N.E. ¼, S. 13, T. 5 N., R. 26 E.	290-295 ft.
13	6	Washington	Rabbitbrush	RM 281, N.E. ¼, S. 13, T. 5 N., R. 26 E.	280-290 ft.
14	6	Washington	Grassland	RM 281, S.E. ¼, S. 12, T. 5 N., R. 26 E.	270-280 ft.
15	6	Washington	Marsh	RM 280, N.E. ¼, S. 11, T. 5 N., R. 26 E.	~263-268 ft.
16	6	Washington	Talus	RM 230, N.W. ¼, S. 34, T. 3 N., R. 19 E.	280-400 ft.
17	6	Washington	Rock cliff/grassland	RM 230, N. ¼, S. 33, T. 3 N., R. 19 E.	400-600 ft.
18	6	Washington	Sagebrush	RM 229, S.E. ¼, S. 20, T. 3 N., R. 19 E.	280-320 ft.
19	6	Washington	Willow/cottonwood	RM 280, N.W. ½, S. 14, T. 5 N., R. 26 E.	~265-270 ft.

Table 16. Plants identified on intensive sampling areas.[1]

TREES

Big-leaf maple - *Acer macrophyllum*
Black cottonwood - *Populus trichocarpa*
Black hawthorn - *Crataegus douglasii*
Columbia River willow - *Salix fluviatilis*
Douglas fir - *Pseudotsuga menziesii*
Great Plains cottonwood - *Populus deltoides*
Hooker willow - *Salix hookeriana*
Oregon ash - *Fraxinus latifolia*
Oregon white oak - *Quercus garryana*
Pacific willow - *Salix lasiandra*
Peach-leaf willow - *Salix amygdaloides*
Piper's willow - *Salix piperi*
Ponderosa pine - *Pinus ponderosa*
Red alder - *Alnus rubra*
Russian olive - *Elaeagnus angustifolia*
Sitka spruce - *Picea sitchensis*
Slender willow - *Salix exigua*
Sour cherry - *Prunus cerasus*
Tree-of-heaven - *Ailanthus altissima*
Vine maple - *Acer circinatum*
Western crabapple - *Pyrus fusca*
Western hemlock - *Tsuga heterophylla*
Western red cedar - *Thuja plicata*
White mulberry - *Morus alba*

SHRUBS

Big sagebrush - *Artemesia tridentata*
Bitterbrush - *Purshia tridentata*
Blackcap - *Rubus leucodermis*
Black twinberry - *Lonicera involucrata*
Blue elderberry - *Sambucus cerulea*
Bristly Nootka rose - *Rosa nutkana*
Buckberry - *Ceanothus integerrimus*
Buckwheat - *Eriogonum spp.*
Climbing nightshade - *Solanum dulcamara*
Coast black gooseberry - *Ribes divaricatum*
Coast red elderberry - *Sambucus racemosa*
Common chokecherry - *Prunus virginiana*
Creambush ocean-spray - *Holodiscus discolor*
Creek dogwood - *Cornus stolonifera*
Dull Oregongrape - *Berberis nervosa*
Evergreen blackberry - *Rubus laciniatus*
Golden currant - *Ribes aureum*
Gray rabbitbrush - *Chrysothamnus nauseosus*
Green rabbitbrush - *Chrysothamnus viscidiflorus*
Hackberry - *Celtis reticulata*
Hazelnut - *Corylus cornuta*
Himalayan blackberry - *Rubus discolor*

Table 16. (cont.)

Little wild rose - *Rosa gymnocarpa*
Long-leaf phlox - *Phlox longifolia*
Low Oregongrape - *Berberis repens*
Northern buckwheat - *Eriogonum compositum*
Pacific blackberry - *Rubus ursinus*
Pacific ninebark - *Physocarpus capitatus*
Phlox - *Phlox spp.*
Poison oak - *Rhus diversiloba*
Rose - *Rosa spp.*
Round-headed eriogonum - *Eriogonum sphaerocephalum*
Salal - *Gaultheria shallon*
Salmonberry - *Rubus spectabilis*
Serviceberry - *Amelanchier alnifolia*
Snakeweed - *Gutierrezia sarothrae*
Snow buckwheat - *Eriogonum niveum*
Snowberry - *Symphoricarpos albus*
Tall Oregongrape - *Berberis aquifolium*
Thimbleberry - *Rubus parviflorus*

FORBS

Alfalfa - *Medicago sativa*
Alsike clover - *Trifolium hybridum*
American brooklime - *Verconica americana*
American glehnia - *Glehnia leiocarpa*
American vetch - *Vicia americana*
American wintercress - *Barbarea orthocera*
Annual fleabane - *Erigeron annuus*
Arrowleaf balsamroot - *Balsamorhiza sagittata*
Arrowleaf groundsel - *Senecio triangularis*
Asparagus - *Asparagus officinalis*
Bachelor's button - *Centaurea cyanus*
Baltic rush - *Juncus balticus*
Beach pea - *Lathyrus japonicus*
Beaked spike-rush - *Eleocharis rostellata*
Bergamot mint - *Mentha citrata*
Bergia - *Bergia texana*
Bigroot - *Marah oreganus*
Birdsfoot-trefoil - *Lotus corniculatus*
Biscuit-root - *Lomatium spp.*
Bluntleaved yellow cress - *Rorippa obtusa*
Bog stitchwort - *Stellaria alsine*
Bracken fern - *Pteridium aquilinum*
Bractless hedge-hyssop - *Gratiola ebracteata*
Brass buttons - *Cotula coronopifolia*
Buckwheat - *Eriogonum spp.*
Bull thistle - *Cirsium vulgare*
Buttercup - *Ranunculus spp.*
Canada goldenrod - *Solidago canadensis*
Canada thistle - *Cirsium arvense*
Canada waterweed - *Elodea canadensis*
Canada wild lettuce - *Lactuca canadensis*

Table 16. (cont.)

Candyflower - *Montia sibirica*
Celeryleaved buttercup - *Ranunculus sceleratus*
Chickweed - *Cerastium spp.*
Chive - *Allium schoenoprasum*
Cleavers - *Galium aparine*
Clover - *Trifolium spp.*
Clustered dock - *Rumex conglomeratus*
Coastal strawberry - *Fragaria chiloensis*
Columbia coreopsis - *Coreopsis atkinsoniana*
Common cat-tail - *Typha latifolia*
Common cocklebur - *Xanthium strumarium*
Common mullein - *Verbascum thapsus*
Common plantain - *Plantago major*
Common reed - *Phragmites communis*
Common rush - *Juncus effusus*
Common St. John - *Hypericum perforatum*
Common spike-rush - *Eleocharis palustris*
Common tarweed - *Madia gracilis*
Cooley's hedge nettle - *Stachys cooleyae*
Corn mint - *Mentha arvensis*
Cow parsnip - *Heracleum lanatum*
Creeping Charlie - *Glecoma hederacea*
Curly dock - *Rumex crispus*
Cut-leaved water horehound - *Lycopus americanus*
Cyperus - *Cyperus erythrorhizos*
Deer-cabbage - *Nephrophyllidium crista-galli*
Deer-fern - *Blechnum spicant*
Delicate sedge - *Eleocharis bella*
Desert plectritis - *Plectritis macrocera*
Diffuse stickweed - *Hackelia diffusa*
Dock - *Rumex spp.*
Douglas' aster - *Aster subspicatus*
Dovefoot geranium - *Geranium molle*
Dry-ground lupine - *Lupinus aridus*
Elegant brodiaea - *Brodiaea elegans*
Elk sedge - *Carex geyeri*
English plantain - *Plantago lanceolata*
Evergreen blackberry - *Rubus laciniatus*
Fairy lantern - *Disporum smithii*
False-brome - *Brachypodium distachyon*
False-dandylion - *Agoseris heterophylla*
False hellebore - *Veratrum californicum*
Fern-leaved lomatium - *Lomatium dissectum*
Fiddle-grass - *Epilobium hirsutum*
Field chickweed - *Cerastium arvense*
Field crest - *Lepidium campestre*
Field filago - *Filago arvensis*
Field milk-thistle - *Sonchus arvensis*
Filaree - *Erodium circutarium*
Fireweed - *Epilobium augustifolium*
Flannel mullein - *Verbascum thapsus*
Flowering quillwort - *Lilaea scilloides*

Table 16. (cont.)

Foxglove - *Digitalis purpurea*
Fringecup - *Tellima grandiflorum*
Gaillardia - *Gaillardia aristata*
Giant helleborine - *Epipactis gigantea*
Giant vetch - *Vicia gigantea*
Goatsbeard - *Tragopogon spp.*
Gosmore - *Hypochaeris radicata*
Gray lomatium - *Lomatium grayi*
Great duckweed - *Spirodela polyrhize*
Great northern aster - *Aster modestus*
Green sedge - *Carex oederi*
Green sorrel - *Rumex acetosa*
Hall's aster - *Aster chilensis*
Hardstem bulrush - *Scirpus acutus*
Harvest fiddleneck - *Amsinckia retrorsa*
Heart-leaved arnica - *Arnica cordifolia*
Hedge bindweed - *Convolvulus sepium*
Hemlock parsley - *Conioselinum pacificum*
Hoary false-yarrow - *Chaenactis douglasii*
Hoary pepperwort - *Cardaria draba*
Hood's sedge - *Carex hoodii*
Hooker's evening-primrose - *Oenathera hookeri*
Hop clover - *Trifolium procumbens*
Horsetail - *Equisetum spp.*
Horseweed - *Conyza canadensis*
Howell's brodiaea - *Brodiaea howellii*
Howell's milk-vetch - *Astragalus howellii*
Indian hemp - *Apocynum sibiricum*
Indian-wheat - *Plantago patagonica*
Inside-out-flower - *Vancouveria hexandra*
Jagged chickweed - *Holosteum umbellatum*
Jointed rush - *Juncus articulatus*
Lacepod - *Thysanocarpus curvipes*
Lady-fern - *Athyrium filix-femina*
Large-leaved lupine - *Lupinus polyphyllis*
Least hop clover - *Trifolium dubuim*
Lesser cat-tail - *Typha angustifolia*
Lettuce - *Lactuca spp.*
Licorice-root - *Glycyrrhiza lepidota*
Lilaeopsis - *Lilaeopsis occidentalis*
Little buttercup - *Ranunculus uncinatus*
Little meadow-foxtail - *Alopecurus aequalis*
Lowland cudweed - *Gnaphalium palustre*
Lupine - *Lupinus spp.*
Lyall nettle - *Urtica lyallii*
Lyngby's sedge - *Carex lyngbyei*
Marsh clubmoss - *Lycopodium inundatum*
Marsh hedge-nettle - *Stachys palutris*
Marsh horsetail - *Equisetum palustre*
Marsh yellowcress - *Rorippa islandica*
Milk-vetch - *Astragalus spp.*

Table 16. (cont.)

Miner's lettuce - *Montia perfoliata*
Moneywort - *Lysimachia nummularia*
Mountain dandylion - *Agoseris spp.*
Mouse-ear chickweed - *Cerastium vulgatum*
Mudwort - *Limosella aquatica*
Munro's globe-mallow - *Sphaeralcea munroana*
Narrow-leaved milkweed - *Asclepias fascicularis*
Nine-leaf lomatium - *Lomatium triternatum*
Nodding beggars-tick - *Bidens cernua*
Northern bedstraw - *Galium boreale*
Northern bugleweed - *Lycopus uniflorus*
Northern clustered sedge - *Carex arcta*
Northern dune tansy - *Tanacetum douglasii*
Northern maidenhair - *Adiantum pedatum*
Northern mule's-ear - *Wyethia amplexicaulis*
Orange balsam - *Impatiens capensis*
Oregon stonecrop - *Sedum oreganum*
Ovoid sedge - *Dulichium ovata*
Oxeye-daisy - *Chrysanthemum leucanthemum*
Pacific bedstraw - *Galium cymosum*
Pacific silverweed - *Potentilla pacifica*
Pacific water-parsley - *Oenanthe sarmentosa*
Paint-brush owl-clover - *Orthocarpus castillejoides*
Pale evening-primrose - *Oenothera pallida*
Pearly-everlasting - *Anaphalis margaritcea*
Pestle parsnip - *Lomatium nudicaule*
Pig-a-back - *Tolmiea menziesii*
Pine woods cryptantha - *Cryptantha simulans*
Pointed rush - *Juncus oxymeris*
Poison-hemlock - *Conium maculatum*
Prairie sage - *Artemisia ludoviciana*
Prickly lettuce - *Lactuca serriola*
Purple beach pea - *Lathyrus japonicus*
Purslane - *Veronica peregrina*
Rabbitfoot polypogon - *Polypogon monspeliensis*
Red clover - *Trifolium pratense*
Red-sepaled evening-primrose - *Oenothera erythrosepala*
River cinquefoil - *Potentilla rivais*
Rough bugleweed - *Lycopus asper*
Rough wallflower - *Erysimum asperum*
Russian thistle - *Salsola kali*
Salt rush - *Juncus lesueurii*
Saltmarsh sandspurry - *Spergularia marina*
Sawbeak sedge - *Carex stipata*
Scalepod - *Idahoa scapigera*
Seacoast angelica - *Angelica lucida*
Seacoast bulrush - *Scirpus maritimus*
Seashore lupine - *Lupinus littoralis*
Self-heal - *Prunella vulgaris*
Sharp-leaved penstemon - *Penstemon acuminatus*
Shepherd's-purse - *Capsella bursa-pastoris*

Table 16. (cont.)

Showy milkweed - *Asclepias speciosa*
Sierra rush - *Juncus nevadensis*
Silverweed - *Pontentilla spp.*
Simplestem bur-reed - *Sparganium emersum*
Skunk cabbage - *Lystichitum americanum*
Slender hawksbeak - *Crepis atrabarba*
Slender rush - *Juncus tenuis*
Slim-leaf onion - *Allium amplectens*
Slough sedge - *Carex obnupta*
Small cleavers - *Galium trifidum*
Small false solomon's seal - *Smilacina sessilifolia*
Small-flowered crane's bill- *Geranium pusillum*
Small-flowered forget-me-not - *Myosotis laxa*
Small-flowered lupine - *Lupinus micranthus*
Small-flowered tonella - *Tonella tenella*
Small-flowered willow-weed - *Epilobium minutum*
Small-fruited bulrush - *Scirpus microcarpus*
Small spike-rush - *Eleocharis parvula*
Smooth cats-ear - *Hypochaeris glabra*
Smooth desert parsley - *Lomatium laevigatum*
Smooth fringecup - *Lithophragma glabra*
Smooth goldenrod - *Solidago gigantea*
Smooth scouring-rush - *Equisetum laevigatum*
Sneezeweed - *Helenium autumnale*
Softstem bulrush - *Scirpus validus*
Sorrel - *Rumex acetosella*
Spatula-leaf stone-crop - *Sedum spathulifolium*
Spearmint - *Mentha spicata*
Spike-rush - *Eleocharis spp.*
Spirea - *Spiraea douglasii*
Spreading rush - *Juncus supiniformis*
Spring-gold - *Crocidium multicaule*
Springbank clover - *Trifolium wormskjoldii*
Spurless balsam - *Impatiens ecalcarata*
Starvation cholla - *Opuntia polyacantha*
Sticky phacelia - *Phacelia glandulifera*
Sticky purple geranium - *Geranium viscosissimum*
Stinging nettle - *Urtica dioica*
Strawberry clover - *Trifolium fragiferum*
Sulfur buckwheat - *Eriogonum umbellatum*
Swainsona - *Swainsona salsula*
Sweet-pea - *Lathyrus spp.*
Sword-fern - *Polystichum munitum*
Tall beggars-tick - *Bidens vulgata*
Tansy ragwort - *Senecio jacobaea*
Tapered rush - *Juncus acuminatus*
Tarweed fiddlenecks - *Amsinckia lycopsoides*
Teasel - *Dipsacus syvestris*
Thick-leaved groundsel - *Senscio crassulus*
Thickleaved thelypody - *Thelypodium laciniatum*
Thread-leaf fleabane - *Erigeron filifolius*
Thread rush - *Juncus filiformis*

Table 16. (cont.)

Three-square bulrush - *Scirpus americanus*
Tiny vetch - *Vicia hirsuta*
Toad rush - *Juncus bufonius*
Torry's rush - *Juncus torreyi*
Tumblemustard - *Sisymbrium altissimum*
Vanillaleaf - *Achlys triphylla*
Varileaf phacelia - *Phacelia heterophylla*
Veined larkspur - *Delphinium lineapetalum*
Veiny dock - *Rumex venosus*
Vetch - *Vicia spp.*
Wapato - *Sagittaria latifolia*
Washington mimulus - *Mimulus washingtonensis*
Water pimpernal - *Veronica anagallis-aquatica*
Water sedge - *Carex aquatilis*
Water smartweed - *Polygonum coccineum*
Waterpepper - *Polygonum hydropiperoides*
Watson's willow-weed - *Epilobium watsonii*
Wavy-leaved thistle - *Criseum undulatum*
Weak-stemmed cryptantha - *Cryptantha flaccida*
Western buttercup - *Ranunculus occidentalis*
Western centaury - *Centaurium exaltatum*
Western dock - *Rumex occidentalis*
Western goldenrod - *Solidago occidentalis*
Western gromwell - *Lithospermum ruderale*
Western St. John's wort - *Hypericum formosum*
Western starflower - *Trientalis latifolia*
Western stickseed - *Lappula redowskii*
Western tansymustard - *Decurainia pinnata*
Western valerian - *Valeriana occidentalis*
White bog-orchid - *Habenaria dilatata*
White clover - *Trifolium repens*
White sweet-clover - *Melilotus alba*
Whiteleaf phacilia - *Phacelia hastata*
Willow-weed - *Epilobium spp.*
Wooley-headed clover - *Trifolium eriocephalum*
Yarrow - *Achillea millfolium*
Yellow beeplant - *Cleome lutea*
Yellow flag - *Iris pseudacorus*
Yellow marshmarigold - *Caltha asarifolia*
Yellow-monkey-flower - *Mimulus guttatus*
Yellow parentucellia - *Parentucellia viscosa*
Yellow salsify - *Tragopogon dubius*
Yellow sandverbena - *Abronia latifolia*
Yellow sedge - *Carex flava*
Yellow sweetclover - *Melilotus officinalis*

GRASSES

Alkali saltgrass - *Distichlis stricta*
Barley - *Hordeum spp.*
Beachgrass - *Ammophila arenaria*

Table 16. (cont.)

Bearded wheatgrass - *Agropyron caninum*
Bluebunch wheatgrass - *Agropyron spicatum*
Bottlebrush squirreltail - *Sitanion hystrix*
Bulbous bluegrass - *Poa bulbosa*
Bur-grass - *Cenchrus longispinus*
Canada bluegrass - *Poa compressa*
Cheatgrass - *Bromus tectorum*
Clasping peppergrass - *Lepidium perforliatum*
Creeping bentgrass - *Agrostis alba*
Creeping wildrye - *Elymus triticoides*
Crested wheatgrass - *Agropyron cristatum*
Cutgrass - *Leersia oryzoides*
Diffuse hairgrass - *Aira elegans*
Dwarf alkaligrass - *Puccinellia pumila*
Early hairgrass - *Aira praecox*
Eel-grass - *Zostera marina*
Fowl mannagrass - *Glyceria striata*
Foxtail barley - *Hordeum jubatum*
Giant wildrye - *Elymus cinereus*
Idaho fescue - *Festuca idahoensis*
Indian ricegrass - *Oryzopsis hymenoides*
Kentucky bluegrass - *Poa pratensis*
Knotgrass - *Paspalum distichum*
Mediterranean barley - *Hordeum geniculatum*
Narrow-flowered brome - *Bromus vulgaris*
Needle-and-thread - *Stipa comata*
Nuttall's fescue - *Festuca microstachys*
Old-witchgrass - *Panicum cipillare*
Orchard-grass - *Dactylis glomerata*
Perrennial ryegrass - *Lolium perenne*
Pine bluegrass - *Poa scabrella*
Prairie Junegrass - *Koeleria cristata*
Reed canarygrass - *Phalaris arundinacea*
Red fescue - *Festuca rubra*
Red threeawn - *Aristida longiseta*
Ripgut - *Bromus rigidus*
Sandberg's bluegrass - *Poa sandbergii*
Seashore brome - *Poa macrantha*
Seaside arrow-grass - *Triglochin maritimum*
Six-week fescue - *Festuca bromoides*
Sloughgrass - *Beckmannia syzigachne*
Soft chess - *Bromus mollis*
Tufted hairgrass - *Deschampsia cespitosa*
Velvet-grass - *Holcus mollis*
Watergrass - *Echinochloa crusgalli*
Western needlegrass - *Stipa occidentalis*
Wheat - *Triticum aestivum*
Wild oat - *Avena fatua*

[1]Common and scientific names from Hitchcock and Cronquist (1973).

Oregon Shore

RM 0-6. Wet beach sand and stabilized foredunes characterize the mouth of the Columbia River. The foredunes run transversely southwest to northeast and give a rolling appearance to the landscape. Coast pine and scotch-broom are invading most areas and range from dense inland stands to scattered individuals near the coastline. European beachgrass dominates vegetated foredunes. Coastal strawberry, Oregon sedum, six-weeks fescue, and early hairgrass occur commonly on upland areas.

Tidal marshes and mudflats occur on the immediate river shoreline in this portion of the river. Some intertidal areas are drained by deep tidal channels. Marsh vegetation occupies distinct vegetative bands between upland dry sites and mud flats. Lyngby's sedge, common reed, creeping bentgrass, and Pacific silverweed are locally dominant species in these marshes.

RM 6-38. Deep, fine textured alluvial soils occur on inside curves of the river; steep, rocky banks characterize "points" protruding into the river. The dramatic tidal action in this area is a very influential factor on vegetation. Open marshland and forested swamps occur on the intertidal islands, overflowing rivers, sloughs, and lagoons. Pacific willow and Hooker's willow form dense stands on islands, occurring predominantly near tidal channels. Lyngby's sedge, slough sedge, skunk cabbage, yellow flag, and creeping bentgrass occur on most islands.

Forested swamps are dominated by Sitka spruce. Black cottonwood forms associations with Sitka spruce on several sites. Western red cedar and Pacific willow are common; in most stands they remain under the canopy of dominant species. Salal forms impenetrable understory thickets. Twinberry, coast red elder, creek dogwood, and blue bindweed are common understory components. Skunk cabbage thrives along tidal channels of forested sites. Pacific water-parsley, slough sedge, and small-flowered forget-me-not are common near tidal channels. Reed canarygrass is abundant along roadways, dikes, and adjacent pasture land.

RM 38-58. Wide flood plains reach inland approximately one mile before meeting mountain slopes. Soils are deep and consist of fine textured alluvial deposits. Many areas located on the river flood plains, including Puget Island, have been diked and are under intensive agricultural use. Black cottonwood dominates riverside forests where they exist. Oregon ash, Pacific willow, and black hawthorn are scattered through the black cottonwood communities. Pacific willow forms dense isolated shrub stands on exposed areas immediately adjacent to the river shoreline.

RM 58-92. The "Coast Range" visually dominates the landscape. Mountain slopes are steep and often form the river shoreline in this portion of the study area. Upland soils have a high clay content. Soils near the river tend to be sandy. Douglas fir/western hemlock communities dominate the mountain slopes. Black cottonwood, red alder, and big-leaf maple are common along mountain drainages and near the river shore. Red alder forms pure stands on old clearcuts and burned sites. Snowberry, oceanspray, California

hazel, and Himalayan berry typify shrub understories on relatively dry forest sites. Pacific rhododendron and salal dominate understories of moist Douglas fir/western hemlock stands. Skunk cabbage, Pacific water-parsley, horsetail, sword fern, yellow sedge and wintercress are common herbaceous species.

Islands in this portion of the study area are typically flat, having few areas above seasonal high water levels. Soils are sandy and contain varying amounts of organic material. Reed canarygrass dominates open areas and is a codominant species in black cottonwood--Pacific willow ecotones. Black cottonwood is the dominant tree species. The understory is completely shaded while leaves persist. Oregon ash has a scattered distribution and usually remains under the main forest canopy. Pacific willow often dominates low areas exposed to high water. High water marks reached four feet above ground level on some willow trunks. Creek dogwood, Himalayan berry, wild trailing blackberry, and blue bindweed occur consistently throughout the island habitats. Stinging nettle dominates black cottonwood understories. Dense stinging nettle populations were 5-7 feet in height during the early summer. Cleavers and wintercress are scattered in isolated openings. Cleavers also form dense tangles at the base of black cottonwood trees and often climb several feet up tree trunks.

This island vegetative pattern remains relatively consistent up to and including Sand Island near Rooster Rock State Park (RM 132). The most conspicuous exception occurs on Sauvies Island (RM 89-92) where Oregon ash increases in density, dominating scattered sites. Its density decreases again to the east.

RM 89-104. Sandy beaches bordered by long, narrow black cottonwood/Pacific willow stands typify the river shore. Deep, sandy loam soils were deposited on broad alluvial plains adjacent to the river. Most areas are under cultivation or managed as pasture. Several lakes and slough channels are located between the Columbia River and Multnomah Channel. Reed canarygrass is the dominant grass on moist pastures. Black cottonwood and Oregon ash communities are common. Creek dogwood, wild trailing blackberry, Himalayan berry, snowberry and wild wood rose are major shrub species. Stinging nettle is the dominant forb associated with black cottonwood communities. Reed canarygrass, moneywort, creeping Charlie, and yellow sedge are locally abundant in both black cottonwood and Oregon ash communities.

RM 104-112. Portland and surrounding urban areas.

RM 112-124. Farmlands occupy much of the landscape. Sandy beaches occur along the river's edge. Soils away from the river are deep, sandy loam and appear to be very productive. Douglas fir is the most conspicuous coniferous species in the forested slopes. Big-leaf maple is common on low moist sites and intermixed with the Douglas fir canopy. Black cottonwood/Pacific willow communities are dominant near the river shore. Himalayan berry, wild trailing blackberry and wild wood rose form occasional dense brambles in the understory. Stinging nettle is the dominant forb. Reed canarygrass forms pure open stands and is the dominant grass in the Pacific willow/black cottonwood communities. Columbia River willow and Pacific willow form dense shrub stands on sites subject to frequent flooding.

RM 124-173. Walls of the Columbia Gorge rise sharply above the river. Soils near the rock cliffs are shallow clay loam. Deep, sandy soils occur near the river. Douglas fir and western hemlock codominate slopes of the gorge. Douglas fir and big-leaf maple provide the forest canopy on plains between the base of the canyon wall and Interstate 80N. Snowberry, California hazel, vine maple, poison oak, and dull Oregon grape are dominant shrub species. Poison oak occurs in dense patches at the base of cliffs near RM 124 and spreads downward, reaching the river shore by RM 173. Sword fern, lady fern, starflower, and wild ginger are common forbs. Pinegrass is scattered under the coniferous canopy.

Near the river, black cottonwood, Pacific willow, and red alder are dominant overstory species. Himalayan berry, wild trailing blackberry, coast red elder, creek dogwood, and blue bindweed are conspicuous species occurring near the river. Stinging nettle and reed canarygrass remain dominant understory species in black cottonwood and Pacific willow communities.

Shrub stands of Columbia River willow and Pacific willow occur on sandy sites. These communities are flooded by up to 5 feet of water for a large portion of the year. The sparse herbaceous cover in these stands consists primarily of green sedge, yellow sedge, and field mint. Large amounts of driftwood accumulate in these areas.

RM 173-189. Steep, rock cliffs form a high canyon wall. The plain between the river and the rock cliffs is narrow. In many areas Interstate 80N occupies the entire plain. Soils are shallow and sandy textured. Ponderosa pine replaces Douglas fir/western hemlock communities common to the west. Oregon white oak is dominant on xeric sites and forms an association with Ponderosa pine on slopes near the river. Snowberry, vine maple, bitterbrush and tall Oregon grape are major shrub species in Ponderosa pine communities. Idaho fescue, bluebunch wheatgrass, and cheatgrass are dominant grass species.

Poison oak forms extremely dense stands under Oregon white oak canopies. Snowberry, oceanspray and Oregon grape add to the shrub diversity.

Pacific willow, Columbia River willow, and peach-leaf willow form dense stands on moist sites near the river. Reed canarygrass dominates the understory. Dogbane, narrow-leaved milkweed, and ladies nightcap are locally abundant.

RM 190-197. A steep slope with short, vertical, rock cliffs forms the canyon wall. Grasses, predominately cheatgrass and Sandberg's bluegrass cover the portions of the steep slopes having a soil layer. Other grasses present in smaller amounts are bluebunch wheatgrass, Idaho fescue, and bulbous bluegrass. Gray rabbitbrush dominates the gentle slope between the base of the steep slope and the river shore. Riparian vegetation composed primarily of willow (peach-leaf and Pacific), Nootka rose, goldenrod, and locust (Robinia sp.) occurs in the low, moist areas along the river shoreline and some islands. Soil in this area appears to be rather deep. Grazing pressure is light over most of the area.

RM 197-204. The canyon wall is a steep slope with two layers of vertical rock cliffs and narrow plateaus above each cliff layer. Gray rabbitbrush is the dominant overstory species on the plateau, but bitterbrush, big sagebrush, and Ceanothus sp. also occur sparingly. Grasses covering the steep slopes and occurring as an understory to the shrubs on the plateaus are primarily cheatgrass and Sandberg's bluegrass. Idaho fescue and bulbous bluegrass are present also. Small patches of willow and alder occur along the river shore and embayments. Soils are fairly deep, and grazing pressure is moderate to light in this portion of the study area.

RM 204-218. Tall, vertical rock cliffs extend to very near the top of the gorge. Talus slopes are common under the cliffs. The steep slope under the cliffs having a soil layer, supports Sandberg's bluegrass, cheatgrass and smaller amounts of needlegrass (Stipa sp.) and bluebunch wheatgrass. The gentle slope between the river's edge and the steep slope supports willow, tree-of-heaven, locust, and white poplar. Gray rabbitbrush with a cheatgrass understory covers most of the gentle slope. Soil is moderately deep at the bottom of the cliff, but becomes gradually shallower and rocky toward the top of the canyon.

RM 218-233. Steep talus slopes extend to the base of the cliffs at the top of the canyon. Hackberry, ceanothus, common chokecherry, and juniper (Juniperus sp.) occur in the perimeter of the talus. Portions of the steep slope not covered with talus are grassland. Near the cliffs, bluebunch wheatgrass, Idaho fescue, and Sandberg's bluegrass are the most common species. Some portions of the slope have crested wheatgrass and bluegrass (Poa sp.) that have been seeded. Cheatgrass is the dominant grass cover in several locations along the canyon wall. Rabbitbrush covers most of the lower part of the slope. Big sagebrush occurs in the bottoms of moist side canyons. Soil is shallow and rocky except in side canyons where it is deeper. Use by cattle is light.

RM 233-253. Gently rising grassy and shrubby slopes characterize this portion of the study area. The immediate shoreline of the river in much of this area is vertical rock cliffs. Gray rabbitbrush with a cheatgrass understory covers most of the area. In scattered locations, bitterbrush, big sagebrush, and green rabbitbrush are codominants with gray rabbitbrush. Other grasses in the area are bluebunch wheatgrass and needlegrass (Stipa sp.). Soil is sandy in the western end and becomes more rocky toward the eastern end. Cattle use appears to be relatively light.

RM 253-270. The land rises in a very gentle slope from the river shore inland--appearing almost flat. Gray rabbitbrush, big sagebrush, bitterbrush, and greasewood seem to be the only shrub species present in the area. Gray rabbitbrush is widespread in the area; big sagebrush and bitterbrush are present on sites having rocky to sandy soil, and greasewood occurs in a few locations just west of Boardman. Livestock use was noted in most areas.

RM 270-292. This is an area of farmland and ponds interspersed with shrubs and grassland. Most of the cropland is located between RM 270 and 281. Ponds are most common from RM 281-292. Shrub cover is almost equally divided between gray rabbitbrush, bitterbrush, and big sagebrush. The predominant grass of the area is cheatgrass and smaller amounts of Sandberg's

bluegrass. Russian olive, willow, cottonwood, and locust occur in some locations along the river shore and many of the ponds. Most ponds in this portion of the study area support lush growth of marsh vegetation dominated by lesser cat-tail. Curly dock, white and yellow sweet-clover, three-square bulrush, soft- and hardstem bulrush, spike-rush, sprangletop, knot-grass, and barnyard grass are among the more prevalent of species found in these marshes. In the moist areas just west of Boardman alkali grass was widespread. Many species of introduced grasses and forbs were identified in the lush vegetation of the Irrigon Wildlife Management Area located between Irrigon and Umatilla. Soil is deep and sandy. Sand dunes occur in several locations. Grazing pressure by cattle is heavy in some areas.

Washington Shore

RM 0-5. Wet beach sand and narrow foredunes are met abruptly by high coastal outcroppings. Mudflats and tidal marshes, located at sea level, are submerged daily by incoming ocean tides. Red alder forms dense pure stands on recently disturbed sites and in bogs. Salmonberry, twinberry, and slough sedge comprise a majority of the understory.

RM 5-47. Mudflats and tidal marshes occur near the river shore, in bays and at the mouths of tributary streams. Soils are deep and contain large amounts of alluvial material. Mountain slopes, forested predominately with Sitka spruce, western hemlock and Douglas fir meet the river's edge. Sitka spruce is most common in the intertidal zone and near the river mouth. Deep clay soils occur on the slopes above tidal influence. Sloughs and bogs occur in intertidal areas. The intertidal zone is well supplied with deep tidal channels. Red alder dominates most recently disturbed and poorly drained bog sites. Salmonberry, twinberry, Hooker's willow, and Pacific willow comprise a majority of the shrub understory. Slough sedge is the dominant herbaceous species.

Black cottonwood, Sitka spruce, and western red cedar are prevalent on well-drained but frequently flooded sites. Salal, salmonberry, wild trailing blackberry, and creek dogwood combine to form dense, essentially impenetrable understories. Skunk cabbage thrives in and along tidal channels. Maidenhair fern, sword fern, small-flowered forget-me-not, and candy flower are well represented in the herbaceous community.

RM 47-80. The Columbia River passes through the "Coastal Range." Soils near the river are composed of deep alluvial deposits. Tidal influence diminishes considerably by RM 80. Seasonal flooding occurs mainly on the Oregon shore which is located on a broad, flat floodplain. Douglas fir and western hemlock are major overstory species of upland areas. Black cottonwood, Pacific willow, and red alder form dense stands on wet sites near the river and its tributaries. Salal, oceanspray, dull Oregon grape, Pacific rhododendron, and California hazel are common shrubs in coniferous habitats; their abundance appears to vary locally. Sword fern, western bracken fern, Oregon wood sorrel, and candy flower are conspicuous forbs associated with the western hemlock/Douglas fir communities. Columbia River willow, creek dogwood, Pacific willow, and blue bindweed are major shrubs on sites dominated by black cottonwood. Stinging nettle and reed canarygrass are prevalent herbaceous species.

RM 80-104. The topography rises gently from the river. Soils adjacent to the river are sandy. Upland soils are of clay loam texture. Much of the area is under cultivation. Black cottonwood, Pacific willow and Oregon ash communities occur on forested sites near the river. Creek dogwood, wild trailing blackberry, and blue bindweed occur in the understories, but yield to the dominance of extremely dense stinging nettle and reed canarygrass stands. Along the river, understories of several communities have been disturbed. Dredge spoil appears to be a major factor in altering understory composition.

RM 104-138. Agricultural, industrial, and urbanized developments occupy most of the land adjacent to the river in this area.

RM 138-161. The north wall of the Columbia Gorge falls sharply to the river shore in most areas. Soils are shallow above the river. Steep talus slopes characterize several sections of the canyon wall. Sandy alluvial deposits are vegetated with dense stands of Pacific willow and Columbia River willow. These sites are few and are subject to frequent flooding. High water marks up to four feet were common in willow stands. Black cottonwood/stinging nettle associations occur on sites near the river that have been well stabilized.

Douglas fir, western hemlock, big-leaf maple, and red alder are conspicuous species on steep mountain slopes. Major shrubs include oceanspray, snowberry, vine maple, and dull Oregon grape.

RM 161-177. The height of the gorge wall continually decreases, but cliffs with steep talus slopes still form most of the canyon wall. There is a constant trend from mesic to xeric habitats from west to east. Soils are generally shallow and rocky with occasional sandy alluvial deposits occurring on low river floodplains. Douglas fir becomes restricted to north facing slopes. Vine maple, oceanspray, California hazel, and dull Oregon grape are dominant shrub species. South facing slopes are dominated by Oregon white oak and Ponderosa pine. Poison oak, snowberry and dull Oregon grape are the dominant shrubs. Idaho fescue and bluebunch wheatgrass are common grasses. Forested sites become open and scattered toward RM 177.

Scattered stands of Pacific willow and peach-leaf willow occur along the river. Forbs common to these sites include: horseweed, common cocklebur, big white sweet-clover, and licorice root. Bluebunch wheatgrass, bentgrass, and cheatgrass are common grasses.

RM 177-190. The topography is broken, rising gently above the river. Short rock cliffs protrude into the water. Soils are sandy and vary from one to several inches deep. Talus is present at the base of cliffs. Forest vegetation has been replaced by arid steppe vegetation. Pacific willow, peach-leaf willow, and locust occur in small shrub stands near the river. Grasses, predominately cheatgrass, cover slopes having a soil layer. Sandberg's bluegrass, bluebunch wheatgrass, and Idaho fescue are less abundant. Gray rabbitbrush is the most conspicuous shrub on upland sites.

RM 190-197. Cliffs with steep talus slopes form the canyon walls in much of this area. Shrubs are found in the edges of talus slopes, below cliff faces, and in narrow, steep-walled creek bottoms. Maple (Acer sp.) dominates the creek bottoms; ceanothus and bittercherry, the talus; and bitterbrush and gray and green rabbitbrush, the slopes. Alder, cottonwood, and willow are found in a few areas along the river shore. The soil is shallow and very rocky. Grazing is light except in flat plateaus above cliffs where it is heavy.

RM 197-200. This portion of the study area is a sloping grassland with a few cliffs and talus slopes. Shrubs are not common in this area. Gray rabbitbrush, bitterbrush, and buckwheat occur on a few locations around talus. Balsamroot (Balsamorhiza sp.) and lupine (Lupinus sp.) are common on the grassy slopes dominated by cheatgrass and Sandberg's bluegrass. Bulbous bluegrass is present near Highway 14. Grazing pressure by livestock is heavy. Soil is rocky and shallow, especially on higher slopes.

RM 200-201.5. Vertical cliffs form the river shoreline in this area. A gently sloping grassland lies between the cliffs on the river shore to the top of the gorge. Predominant grasses are cheatgrass, Sandberg's bluegrass, and bulbous bluegrass. Some lupine and gray rabbitbrush occur on the slope. Soil is moderately deep and slightly rocky. Grazing pressure is heavy.

RM 201.5-203. Rolling grassland extends to the river shore. Area is similar to that of RM 197-200. Shrubs are rare. The major grasses are bluebunch wheatgrass, Sandberg's bluegrass, and cheatgrass. Soils are moderately deep. The area is heavily grazed.

RM 203-215.5. Rock cliffs and talus slopes form most of this portion of the study area. Most of the immediate river shoreline is rock rip-rap. Shrub cover is limited to a few areas near river level on gentle slopes. In sandy locations, bitterbrush predominates and on rocky areas, gray rabbitbrush is dominant. Cheatgrass and Sandberg's bluegrass are predominant on the steep slopes associated with the cliffs and the grassland above the cliffs. Soils are shallow and rocky. Use by livestock is confined primarily to grassland above the cliffs.

RM 215.5-228.5. Vertical, rock cliffs form the river shoreline. A plateau is present between the cliff and the slopes to the north. This area is rather heavily grazed pasture containing some potholes surrounded by currant (Ribes sp.) and ceanothus. A few locations on the plateau support gray and green rabbitbrush and bitterbrush. The major grass is bluebunch wheatgrass; sedges and rushes are common. Soils are thin and the water table is high.

RM 228.5-236. Vertical cliff faces and talus slopes make up the canyon wall. Hackberry shrubs occur sparingly in the talus. Gray and green rabbitbrush, buckwheat, and a small amount of big sagebrush occur on the lower portions of slopes and in the draws. The most common grasses are Sandberg's bluegrass and cheatgrass with some large areas of bluebunch wheatgrass. Most of the immediate shoreline is rock rip-rap and wheatgrass. Soil is rocky. Grazing is confined to areas above cliffs.

RM 236-262. Green rabbitbrush dominates the shrub layer of vegetation on the slopes well above river level. Near the river shore, on gravel and sandy soil, gray rabbitbrush and widely scattered bitterbrush, big sagebrush, and willow occur. Sandberg's bluegrass and cheatgrass are the most common grasses. Some western needlegrass and bluebunch wheatgrass are present in rocky outcroppings. Soil is sandy near the river and rocky higher up on the slope. Grazing pressure is light.

RM 262-292. Topography is gently rising slope to almost flat in some areas. Area is mostly grass and shrublands with some marshes. Green and gray rabbitbrush are the major shrub species over most of the area. Bitterbrush and big sagebrush dominate the sandy areas. Cheatgrass and Sandberg's bluegrass are the major grasses. Crested wheatgrass and wheatgrass needlegrass occur near Patterson Slough. Cottonwood and willow occur in patches along the river shore, especially in sloughs. Marshes in this area support cat-tail, bulrush, sedges, and smartweed as major vegetation. Soils tend to be sandy near the river and have more clay content on the slopes above the river. Grazing pressure is light.

Tidal Marsh Vegetation of Islands Between RM 20 and RM 34

Most of the 6,580 acres of tidal marsh occurring in segment 2 (Table 6) is found on approximately 20 major islands within the Lewis and Clark NWR. Intensive, quantitative sampling of marsh vegetation was done on only two of these islands, Quinns and Welch, but most of the others were examined closely using non-quantitative methods in August, 1974. A list of plant species and an indication of abundance for each species found in the marshes of the islands is present in Table 17.

Grassy Island (RM 22). The deposits forming this island have a northwest orientation. The older deposits are along the southern edge, extending into younger sand deposits to the northwest and northeast. The entire island is tidal marsh. The older deposits are dominated by Lyngby's sedge and the younger deposits by softstem bulrush and seacoast bulrush. Lyngby's sedge grows under the two species of bulrush but is abundant only along the more elevated southern edge. Douglas' aster, western water-hemlock, and yellow monkey-flower are occasionally present in this association. Tufted hairgrass is rare. Pointed rush is moderately abundant in the area dominated by Lyngby's sedge. Hall's aster was the visual dominant in August 1974, being very abundant for an herbaceous species in this association. Softstem bulrush is somewhat less abundant than seacoast bulrush. The two species each dominate sections of the island as well as codominating a fairly large area. Water smartweed and American water-plantain occur with the bulrushes. The northeastern area grades into beaked spike-rush.

Unnamed Islands near Oregon Shore between RM 21 and RM 23. These islands are entirely tidal marsh. Lyngby's sedge in association with smaller amounts of pointed rush and tufted hairgrass dominates the southern edges of these islands. The lower sand flats to the west and north are dominated by softstem bulrush and seacoast bulrush, the latter is more clearly prevalent along the northeast extension of the eastern-most island which appears to be a new area of deposition. In the area dominated by Lyngby's sedge, Hall's aster, western water-hemlock, Pacific water-parsley, yellow monkey-flower, and waterpepper are also prevalent. Western water-hemlock was the visual dominant in August 1974. Patches dominated by marsh horsetail, reed canarygrass and skunk cabbage graded into the Lyngby's sedge association. Wapato is the only other major species. It dominates an area between the Lyngby's sedge association and the sand flats of softstem bulrush and seacoast bulrush on the western-most island. Most of these species averaged approximately 12 decimeters in height except for seacoast bulrush which was 15 decimeters and wapato which was about 10 decimeters.

Green Island. The northeast section of this island has the highest elevation and is dominated by Lyngby's sedge. Several extensive sand deposits of low elevation occur on the north and southwest part of the island. These sand flats are covered by patches of softstem bulrush, seacoast bulrush, and beaked spike-rush. Softstem bulrush is the most abundant and seemingly the most suited to deep water. The area dominated by Lyngby's sedge also contains pointed rush, tufted hairgrass, western water-hemlock, Hall's aster, and yellow monkey-flower in small amounts. Lesser cat-tail and reed canarygrass occasionally form pure stands in this area.

Russian and Seal Islands. Russian and Seal Islands are an area of deposition similar to but older than that of the unnamed islands between RM 21-23. Vegetation is entirely tidal marsh. The proportion of the islands dominated by the more mature Lyngby's sedge/pointed rush/tufted hairgrass association in relation to that dominated by the younger softstem bulrush or seacoast bulrush associations is about nine to one for Russian and Seal Islands, whereas it is about four to six for the unnamed islands. The area of most recent deposition for Russian and Seal Islands are along the northwest and southwest sides. Softstem bulrush and seacoast bulrush dominate these sandflats. The area dominated by Lyngby's sedge contains a higher percentage of pointed rush and tufted hairgrass, the latter being particularly abundant along the elevated banks of tide channels. Pacific water-parsley, western water-hemlock, and Hall's aster were the most common visual dominants in August. Yellow monkey-flower, due to its conspicuous yellow flowers, was also easily seen. Wapato, Pacific silverweed, and small-flowered forget-me-not occurs with moderate frequency in association with each other and Lyngby's sedge. Water smartweed, deer-cabbage, Douglas' aster, Watson's willow-weed, field mint, nodding beggars-tick, skunk cabbage, and reed canarygrass were species commonly noted that had low cover values. Some undetermined species of marsh grasses other than tufted hairgrass occur on these islands. Lesser cat-tail and beaked spike-rush dominate some patches of vegetation, the latter occurs most frequently in tide channels. The weedy species, sneezeweed, arrowleaf groundsel and self-heal may have been introduced by the more frequent human use of the islands. Patches of softstem bulrush and less frequently seacoast bulrush are found along the northwest edge of both islands. A fairly large patch of softstem bulrush occurs on the northwest tip of Russian Island. It and seacoast bulrush occur in pure stands as well as in association with each other and Lyngby's sedge along the southwestern shore of Russian Island. Marsh horsetail also forms patches in which it is the dominant species. Wapato is the most abundant species on the tidal flat that extends from the southwest corner of Russian Island.

Minnaker Island. Most of Minnaker Island is dominated by Lyngby's sedge. Pointed rush and tufted hairgrass are important components of the vegetation though not as prevalent as on some of the other islands. Pacific willows are becoming established in a few places. Hall's aster and yellow monkey-flower are two herbaceous species that maintain a moderate density throughout the association. Nodding beggars-tick is locally abundant. Pacific water-parsley, western water-hemlock, sneezeweed, Watson's willow-weed, Pacific silverweed, and Douglas' aster occur at low densities. A few plants of the following species are scattered over the area: self-heal, small-flowered forget-me-not, rough bugleweed, fowl mannagrass, Pacific bedstraw, deer-cabbage, large-leaved lupine, cutgrass, and field mint. White bog-orchid is rare.

Patches of softstem bulrush and beaked spike-rush dominate the younger shorelines. A few large individuals of skunk cabbage and American water-plantain grow with these species. Lesser cat-tail and wapato dominate some areas. Water smartweed and lilaeopsis are frequent understory species.

Karlson Island. Only the western end of Karlson Island is undisturbed tidal marsh. Much of the island has been diked (no longer functional, however) or is forested by Sitka spruce and Pacific willow. Most of the tidal

marsh is the Lyngby's sedge/pointed rush/tufted hairgrass association, this occupies the southern half of the marsh except for the extreme western edge. The western edge is a "low" marsh dominated by softstem bulrush. A large stand of common reed forms the northern edge of the marsh. A stand of marsh horsetail is adjacent to the southern edge of the reed stand. Wapato and western water-hemlock are common plants on portions of the marsh.

Snag Island. The older northeast section of this island, dominated by Lyngby's sedge, slopes into extensive sand flats dominated by stands of softstem bulrush, seacoast bulrush, and beaked spike-rush. In the older area the following species normally associated with Lyngby's sedge are found: Watson's willow-weed, Hall's aster, pointed rush, tufted hairgrass, and western water-hemlock. Douglas' aster is abundant in a narrow area on the southeast beach. Individuals of Lyngby's sedge extend into the beaked spike-rush/softstem bulrush dominated area, accompanied by a few yellow monkey-flowers. Lyngby's sedge growing on Snag Island is on the whole shorter with less vegetative growth than those on most other islands. The density of beaked spike-rush is lower here too. Mudwort and lilaeopsis (possibly flowering quillwort) grow in patches of high density in the understory of the stands of beaked spike-rush and softstem bulrush. The stands of seacoast bulrush are very tall and thick. They are the only species other than Douglas' aster which looked really healthy and robust. Lesser cat-tail is also present in patches.

Marsh, Brush and Horseshoe Islands. Approximately 75 percent of the acreage of Brush and Horseshoe Islands is tidal marsh. Only about 20 percent of Marsh Island is tidal marsh. The marsh vegetation of these islands is another example of intertidal freshwater marsh dominated by Lyngby's sedge in association with tufted hairgrass and pointed rush. The hairgrass has a higher percent cover value (30%) on these islands than it does on the islands previously described. When in bloom yellow monkey-flower is a visual dominant. Sneezeweed is unusually plentiful here and due to its conspicuous blooms is considered a visual dominant. In areas where marsh horsetail is codominant with Lyngby's sedge, other species listed above, especially tufted hairgrass, decrease markedly in density. Simplestem bur-reed and American water-plantain are the most abundant species in tide channels. Other conspicuous herbaceous plants normally found on other islands but occurring here in limited numbers were: Pacific water-parsley, western water-hemlock, Hall's aster, Douglas' aster, Pacific silverweed, small-flowered forget-me-not, and Pacific bedstraw. All the common marsh grasses, fowl mannagrass, dwarf alkali-grass, and reed canarygrass are present but not numerous. Waterpepper, deer-cabbage and field mint though not readily noticeable, maintain a low percent cover value throughout the marsh. Beach pea and springbank clover, not often seen on many of the other islands but common on the mainland, were growing on Horseshoe. Some uncommon plants noted included large-leaved lupine, western St. John's-wort, arrowleaf groundsel, and false hellebore.

Woody Island. A dense stand composed of Sitka spruce, western red cedar, creek dogwood, and Pacific willow covers approximately 60 percent of Woody Island. A narrow band of marsh extends around the island and is more extensive on the southern shore adjacent to Horseshoe and Tronson Islands. The dominant marsh type is the Lyngby's sedge/pointed rush/tufted hairgrass association. There are patches dominated by marsh horsetail, reed canarygrass,

and softstem bulrush also. A small area on the western end of the island has an unusual assemblage of plants consisting of spreading rush, simple-stem bur-reed and occasional individuals of Sierra rush, saltmarsh sand-spurry, arrowleaf groundsel, and a small fern. These species grow in the tide channels. Also observed here was the largest number of giant helleborine (approximately 20 plants) encountered on the river. Sneezeweed is moderately abundant on Woody Island. Bergamont mint and self-heal are also present. Other species more common to the Lyngby's sedge association were growing scattered through the rest of the marsh: fowl mannagrass, small-flowered forget-me-not, western water-hemlock, Pacific water-parsley, Hall's aster, great northern aster, yellow monkey-flower, and Pacific silverweed.

Tronson Island. Approximately 10-15 percent of this island is covered by Pacific willow shrubs, the remainder is tidal marsh composed mainly of Lyngby's sedge/pointed rush/tufted hairgrass association. Marsh horsetail is an additional dominant in depressions. Hall's aster and yellow monkey-flower are moderately abundant visual dominants. Pacific silverweed and field mint are two other species with relatively high numbers. Watson's willow-weed, American water-plantain, western water-hemlock, deer cabbage, skunk cabbage, Pacific water-parsley, and wapato form the common complement of plants with low cover and high frequency values for this vegetation type. Relatively rare species are: large-leaved lupine, white bog-orchid, sneeze-weed, and self-heal. Nodding beggars-tick, small-flowered forget-me-not, field mint, fowl mannagrass, reed canarygrass, and Douglas' aster species not as commonly found in Lyngby's sedge marshes as the first group listed, occur on Tronson with moderate frequency and low percent cover values. Stinging nettle and springbank clover are two species rarely found on the islands, though common on the mainland, which grew on Tronson.

Goose Island. This small island adjacent to the north side of Tronson Island is covered by tidal marsh. The Lyngby's sedge/pointed rush/tufted hairgrass association dominates the high ground. Hall's aster and yellow monkey-flower are two of the few herbaceous plants growing with Lyngby's sedge. On the sandy, low deposition of the southwest side, beaked spike-rush and spreading rush are the dominant species. Softstem bulrush, wapato, American water-plantain, reed canarygrass, and waterpepper are also present but not as well represented as the species mentioned above. Mudwort, bergia, and flowering quillwort grew abundantly alone or in combination as the major understory species.

Grassy and Quinns Islands. These two islands have similar vegetation. A narrow stand of Pacific willow occurs on the older eastern shore of Quinns Island. The Lyngby's sedge/pointed rush/tufted hairgrass association extends from the trees into sandflats dominated by patches of softstem bulrush and beaked spike-rush. Herbaceous species found primarily under the willows but also in the sedge marsh are: beach pea, vetch, self-heal, great northern aster, Hall's aster, Sierra rush, Watson's willow-weed, large-leaved lupine, curly dock, small-flowered forget-me-not, western water-hemlock, nodding beggars-tick, sneezeweed, springbank clover and water smartweed. None of these species are abundant. Giant helleborine, white bog-orchid, smooth goldenrod and tansy ragwort are all rare. Pacific silver-weed, yellow monkey-flower and field mint are more prevalent. Marsh horse-tail, reed canarygrass and lesser cat-tail form occasional patches. American water-plantain and some wapato grow in the tide channels. These

two species are the only ones present in the Lyngby's sedge dominated marsh that also occur with moderate frequency in the area dominated by softstem bulrush and beaked spike-rush.

Fitzpatrick Island. The island has a concave surface. The southwest shore which is elevated a meter or more above the river bottom is edged with Salix sp. Adjacent to the northern section of the willow band is a sizeable patch of lesser cat-tail. The number of species associated with the dominant Lyngby's sedge found at the edge of the willows decreases toward the center and increases again on the elevated northeastern and southern edges of the island. Scattered Pacific willows are growing in these higher areas. Understory to the Pacific willow is primarily toad rush, waterpepper, and orange balsam. Sneezeweed, birdsfoot-trefoil, self-heal, and curly dock are relatively rare under the willows, Lyngby's sedge, (approximately 12 inches tall), is the main component of the vegetation of the rest of the island. In the concave central area, wapato and skunk cabbage are the most prevalent additional species, though their percent cover values were low. Pointed rush, marsh horsetail, Hall's aster and the tall grasses including tufted hairgrass, fowl mannagrass and cutgrass are the main species associated with Lyngby's sedge on the higher edges to the north and south. At the time the survey was taken (August 1974) Hall's aster was in full bloom, making it the most visually conspicuous plant. Yellow monkey-flower and western water-hemlock were the other two visual dominants. Beaked spike-rush dominates the tide channels.

Table 17. Occurrence and estimates of abundance of plants found on islands in Lewis and Clark NWR, segment 2.

Plants	Lois I.	Grassy, #1 I.	(Raft) I.	(Vee) I.	Green I.	Russian I.	Seal I.	Minnaker I.	Karlson I.	Snag I.	Marsh, Bush, and Horseshoe I.	Woody I.	Goose I.	Tronson I.	Grassy, #2 I.	Quinns I.	Fitzpatrick I.	Welch I.	Tenasillahe I.
American brooklime	-	-	-	-	-	-	-	-	0[1]	-	-	-	-	-	-	-	-	-	-
American water-plantain	-	0	-	-	-	-	-	0	R	-	0	0	0	0	-	-	-	0	-
Arrowleaf groundsel	-	-	-	-	-	-	O/M	-	-	-	0	M	-	-	-	-	-	-	-
Beach pea	-	0	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-
Beaked spike-rush	LA	LA	-	-	LA	M	-	-	-	M/LA	-	-	-	-	LA	LA	LA	LA	-
Bergamot mint	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-
Bergia	-	-	-	-	-	-	-	-	-	-	-	-	LA	-	-	LA	-	-	-
Birdsfoot-trefoil	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	0	-	-
Canadian thistle	-	-	-	-	-	-	-	-	-	LA	-	-	-	-	-	-	-	-	LA
Celery-leaved buttercup	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-
Clustered dock	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Common rush	-	-	-	-	-	-	-	-	M/LA	-	-	-	-	-	-	-	-	-	-
Creeping bentgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
Curly dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	R	-	-
Cutgrass	-	-	-	-	-	-	-	M	-	0	-	-	-	-	-	-	O/LA	0	-
Deer-cabbage	-	0	0	-	-	-	0	-	-	-	0	0	-	0	-	-	M	M	-
Douglas' aster	-	0	-	-	-	-	0	0	-	M	0	-	-	0	-	-	-	-	-
Dwarf alkaligrass	-	-	-	-	-	-	0	M	-	-	0	-	-	-	-	-	-	-	-
Evergreen blackberry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
False hellebore	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-
Field mint	-	-	-	-	-	0	-	0	0	-	0	-	-	M	M	0	M	0	-
Flowering quillwort	-	-	-	-	-	-	-	-	-	-	-	-	LA	-	-	-	-	-	-
Fowl mannagrass	-	-	-	-	-	-	-	0	0	-	0	0	-	0	-	-	M	0	-
Giant helleborine	-	-	-	-	-	-	-	-	-	-	-	LA	-	-	R	R	-	R	-
Great northern aster	-	-	-	-	-	-	-	-	-	-	-	0	-	-	0	-	-	-	-
Hall's aster	-	M/LA	0	O/M	0	M	M	M	-	O/M	0	0	-	M	0	0	M	M	-

Table 17. Continued.

Plants	Lois I.	Grassy, #1 I.	(Raft) I.	(Vee) I.	Green I.	Russian I.	Seal I.	Minnaker I.	Karlson I.	Snag I.	Marsh, Bush, and Horseshoe I.	Woody I.	Goose I.	Tronson I.	Grassy, #2 I.	Quinns I.	Fitzpatrick I.	Welch I.	Tenasillahe I.
Himalayan blackberry	-	-	-	-	-	-	-	-	LA	-	-	-	-	-	-	-	-	-	-
Large-leaved lupine	-	-	-	-	-	O/M	O/M	O	-	-	R	-	-	R	-	O	-	R	-
Lesser cat-tail	-	O	-	-	M/A	LA	-	-	-	LA	-	-	-	-	O	O	LA	-	-
Lilaeopsis	-	-	-	-	-	-	-	-	-	LA	-	-	-	-	-	-	-	-	-
Little meadow-foxtail	-	-	-	-	-	-	-	-	M	-	-	-	-	-	-	-	-	-	-
Lyngby's sedge	A	LA	OA	O/M	M	M/A	A	A	O/A	M/A	A	A	LA	A	A	LA	A	A	-
Marsh clubmoss	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LA
Marsh horsetail	-	-	LA	-	-	M/A	-	-	LA	-	-	O/LA	-	O/LA	LA	O	M	-	-
Marsh yellowcress	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-
Mayweed chamomile	-	-	-	-	-	-	-	-	LA	-	0	-	-	-	-	-	-	-	-
Mudwort	-	-	-	-	-	-	-	-	-	0	-	-	LA	-	-	LA	-	-	-
Nodding beggars-tick	-	O/M	-	-	-	O/M	0	LA	0	0	0	-	-	0	0	-	-	R	-
Old witchgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
Orange balsam	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	0	0	0	0
Pacific bedstraw	-	-	-	-	-	-	-	0	-	-	0	-	-	-	-	-	0	0	-
Pacific silverweed	-	M	-	-	-	O/M	0	0	R	-	0	0	-	M	O/M	0	0	-	-
Pacific water-parsley	-	-	-	0	-	0	O/M	0	-	-	0	-	-	0	-	-	0	M	-
Pointed rush	M	O/M	O/M	O/M	O/M	M	M	M	O/M	O/M	M	O/M	M	M	M	0	M	M	-
Reed canarygrass	LA	-	LA	LA	0	0	0	-	-	-	0	0	0	0	0	LA	-	-	-
Rough bugleweed	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-
Sawbeak sedge	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
Seacoast angelica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Seacoast bulrush	-	M/A	O/LA	O/LA	LA	M	-	-	-	LA	-	-	-	-	-	-	-	-	-
Self-heal	-	O	-	-	-	0	0	0	-	-	0	0	-	0	0	-	R	0	-
Simpleton bur-reed	-	-	-	-	-	-	-	-	0	-	0	LA	-	-	-	-	-	-	-
Skunk cabbage	-	-	0	-	-	0	0	-	-	-	0	0	-	0	-	-	0	0	-
Sloughgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-

Table 17. Continued.

Plants	Lois I.	Grassy, #1 I.	(Raft) I.	(Vee) I.	Green I.	Russian I.	Seal I.	Minnaker I.	Karlson I.	Snag I.	Marsh, Bush, and Horseshoe I.	Woody I.	Goose I.	Tronson I.	Grassy, #2 I.	Quinns I.	Fitzpatrick I.	Welch I.	Tenasillahe I.
Small-flowered forget-me-not	-	0	-	-	-	0/M	-	0	-	-	0	0	-	0	0	-	0	0/M	-
Small-fruited bulrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Smooth goldenrod	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-
Sneezeweed	-	0/M	-	-	-	-	0	0	M	-	-	LA	-	0	0	0	R	0	-
Softstem bulrush	LA	M/A	0/M	0/M	M/A	0/A	0/M	LA	M/A	LA	LA	-	0	-	A	A	-	-	-
Spirea	-	-	-	-	-	-	-	-	LA	-	-	-	-	-	-	-	-	-	-
Springbank clover	-	-	-	-	-	-	-	-	-	-	0	-	-	0	0	-	-	-	-
Stinging nettle	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	LA
Tansy ragwort	-	0	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-
Thread rush	-	-	-	-	-	-	-	LA	-	-	-	-	-	-	-	-	-	-	-
Toad rush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
Tufted hairgrass	0	0/M	0	0/LA	0/M	0/LA	M	0	0	0/M	M	M	LA	M	M	-	M	0	-
Wapato	-	-	LA	0/M	-	0/LA	0	0/A	LA	-	0	-	0	0	0	0	0	0	-
Waterpepper	-	M	-	0	-	0	-	0	LA	-	0	0	0	-	0	0	M	M	0
Watson's willow-weed	-	0	-	-	-	0	0/M	0	R	0	0	-	-	0	0	0	0	0	-
Western St. John's wort	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-
Western water-hemlock	-	0	0/M	M	0	0/M	0	0	0/M	0	0	0	0	0	0	-	M	-	-
White bog-orchid	-	R	-	-	-	-	-	R	-	-	0	-	-	R	R	-	R	R	-
Yellow flag	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	R	-
Yellow monkey-flower	-	0	0/M	0/LA	0	-	0	-	0	0	M	0	-	M	0/M	0	M	M	-

[1] A = abundant
LA = locally abundant
M = moderate
0 = occasional
R = rare

QUANTITATIVE DESCRIPTION OF INTENSIVE SAMPLING AREAS

Sampling area: 1, segment 1

Habitat: Beachgrass

Location: Oregon shore; RM 5; E. ½ S. 35, T. 8 N., R. 11 W.; Ft. Stevens State Park. The sampling area is bordered on the north and west by sandy beach, on the east by encroaching coast pine and scotch broom, and on the south by the south jetty.

Size of area: Approximately 1 mile long and 100-300 yards wide

Slope: None; the landscape has a "dune" appearance.

Aspect: None

Elevation: Near sea level

Soil: Sand; the sand contains moderate amounts of organic matter near the surface.

Vegetation: The vegetative cover is composed of a mixture of grasses, grasslikes, forbs, and a few scattered shrubs. Of these, beachgrass provides the greatest percent cover, followed by coastal strawberry, *Carex* sp., *Juncus* sp., and green sorrel, respectively (Table 18).

No trees are located in the immediate vicinity. Hooker's willow appeared occasionally in the stand as a shrub.

Ground coverage: Live vegetation 12 percent, litter 57 percent, bare ground 31 percent

Table 18. Vegetative composition of intensive sampling area 1 (beachgrass), segment 1.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[1] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[1] AREA (ft)
Hooker's willow[2]	shrub	--	--	--	--	--	--	--	--
Coast strawberry	forb	90	1.35	--	--	--	--	--	--
Seashore lupine	forb	15	0.15	--	--	--	--	--	--
Red sorrel	forb	55	0.45	--	--	--	--	--	--
False dandylion	forb	30	0.2	--	--	--	--	--	--
Carex spp.	forb	35	0.5	--	--	--	--	--	--
Field chickweed	forb	25	0.1	--	--	--	--	--	--
Small cleavers	forb	20	0.05	--	--	--	--	--	--
Juncus spp.	forb	20	0.35	--	--	--	--	--	--
Red clover[2]	forb	--	--	--	--	--	--	--	--
Sword fern[2]	forb	--	--	--	--	--	--	--	--
English plantain[2]	forb	--	--	--	--	--	--	--	--
Oregon sedum[2]	forb	--	--	--	--	--	--	--	--
Carex spp.[2]	forb	--	--	--	--	--	--	--	--
European beachgrass	grass	70	8.05	--	--	--	--	--	--
Soft chess	grass	65	0.3	--	--	--	--	--	--
Hairgrass	grass	35	0.25	--	--	--	--	--	--
Six weeks fescue[2]	grass	--	--	--	--	--	--	--	--

[1]Basal area for forbs, canopy cover for shrubs and trees.
[2]Species was present in stand but did not occur in sample plots.

Sampling area: 2, segment 1

Habitat: Tidal marsh

Location: Oregon shore; RM 7; N.W. ¼ S. 6, T. 8 N., R. 10 W; Ft. Stevens State Park. The marsh is bounded by a stand of scotchbroom on the upland side and a sand-mud flat on the river side.

Size of area: The sampling area was approximately 500 yards long and 170 yards wide. The sampling area was part of a stand at least three times as large.

Slope: 1-5 percent

Aspect: W., N.W. (310°)

Sampling methods: Sampling was done with a 1 x 1 m frame at 10 m intervals along four transects. The transects began at the edge of the upland vegetation of the dune area and ran parallel to the environmental gradient from the dry upper area to the mud flat. Transects were 100 yards apart and passed through the bands of vegetation perpendicularly.

Vegetation: Species of plants identified in the sampling area are listed in Table 19. Distribution and coverage of dominant species found in the sampling area are shown in Figure 1.

The upper ends of the transects in this sampling area were located in an ecotone between upland vegetation and mature high marsh vegetation. This transition zone was 10-20 m wide, covering about 10 percent of the sampling area. Species found in this zone that are characteristically upland species were seacoast angelica (15%)*, unidentified #7 (10%), northern dune tansy (5%), slough sedge (3%), yarrow (1%) and English plantain (<1%). These species all had low frequencies of occurrence as well as low percent cover values, indicating that they were near the lower limit of their range. Another group of plants had their highest frequencies and cover values in this transition zone and the zones adjacent to it. This group included common reed (21%), thread rush (20%), beach pea (10%), great northern aster (5%) and springbank clover (<1%).

Two of the primary high marsh species, Pacific silverweed (27%) and creeping bentgrass (23%), had cover values and frequencies comparable to the above mentioned species but represent relatively low values for the two species along the gradient. The occurrence of both upland and marsh plants makes this an area of high species diversity.

The transition zone grades into areas where either Pacific silverweed or creeping bentgrass dominates. In three out of four transects a band dominated by Pacific silverweed (58%) was encountered before a band dominated by creeping bentgrass. The silverweed zone starts 10-20 m from the bank, varies in width from 10 to 40 m and covers about 10 percent of the sample area. Creeping bentgrass (27%) occurs throughout the zone (100% frequency). Thread

*Denotes percent cover unless otherwise specified.

rush (30%) and common reed (40%) are found in patches. Beach pea (6%) and great northern aster (2%) are scattered throughout the zone. Field mint and Pacific bedstraw were present in small numbers.

The zone dominated by creeping bentgrass (74%) was 30-60 m wide, covering almost 30 percent of the sample area. It started at 20 m from the beginning of the sample area in the middle and at 40 m to either side. This zone wasn't picked up on the far west side of the sample area until 100 m out. Pacific silverweed (15%) is apparently invading this zone (64% frequency). Other species found in the silverweed dominated zone included beach pea (10%), great northern aster (9%), common reed (10%) and field mint (6%). Springbank clover and false-brome were recorded. Two species, Lyngby's sedge (13%) and seaside arrow-grass (5%), from the next zone persisted at low levels.

An intermediate zone codominated by creeping bentgrass (46%) and Lyngby's sedge (48%) exists between the zones dominated by each of them. It is 10-20 m wide, accounting for almost another 10 percent of the sample area. Pacific silverweed (4%) extends into this zone with a low cover value but high frequency. Seaside arrow-grass (7%) and tufted hairgrass (3%) were also found in this band.

The band dominated by Lyngby's sedge (90%) begins 60-120 m from the edge of the sample area. It varies in width from 30-100 m and covers approximately 50 percent of the sample area. Creeping bentgrass (9%) and Pacific silverweed (4%) have very low percent cover values, but their high frequency values indicate that they are colonizing this zone. Pacific bedstraw, great northern aster and beach pea are other species that have extended into this zone. Seaside arrow-grass (3%) is moderately frequent.

The density of Lyngby's sedge (38%) drops off rapidly at the end of the sample area. Small numbers of seaside arrow-grass (5%), tufted hairgrass (10%) and remnant populations of three-square bulrush are located here. Lilaeopsis (1%) does not have a high percent cover value but occurs in large numbers with moderate frequency in the understory of this zone.

Table 19. Plants identified in sampling area 2 (tidal marsh), segment 1.

Yarrow
Creeping bentgrass
Seacoase angelica
Great northern aster
False-brome
Lyngby's sedge
Slough sedge
Hemlock parsley
Tufted hairgrass
Pacific bedstraw
Thread rush
Beach pea
Lilaeopsis
Field mint
English plantain
Pacific silverweed
Three-square bulrush
Northern dune tansy
Springbank clover
Arrow-grass
*Beachgrass
*Beaked spike-rush
*Lesser cat-tail
*Eel-grass

*In area but not recorded in data.

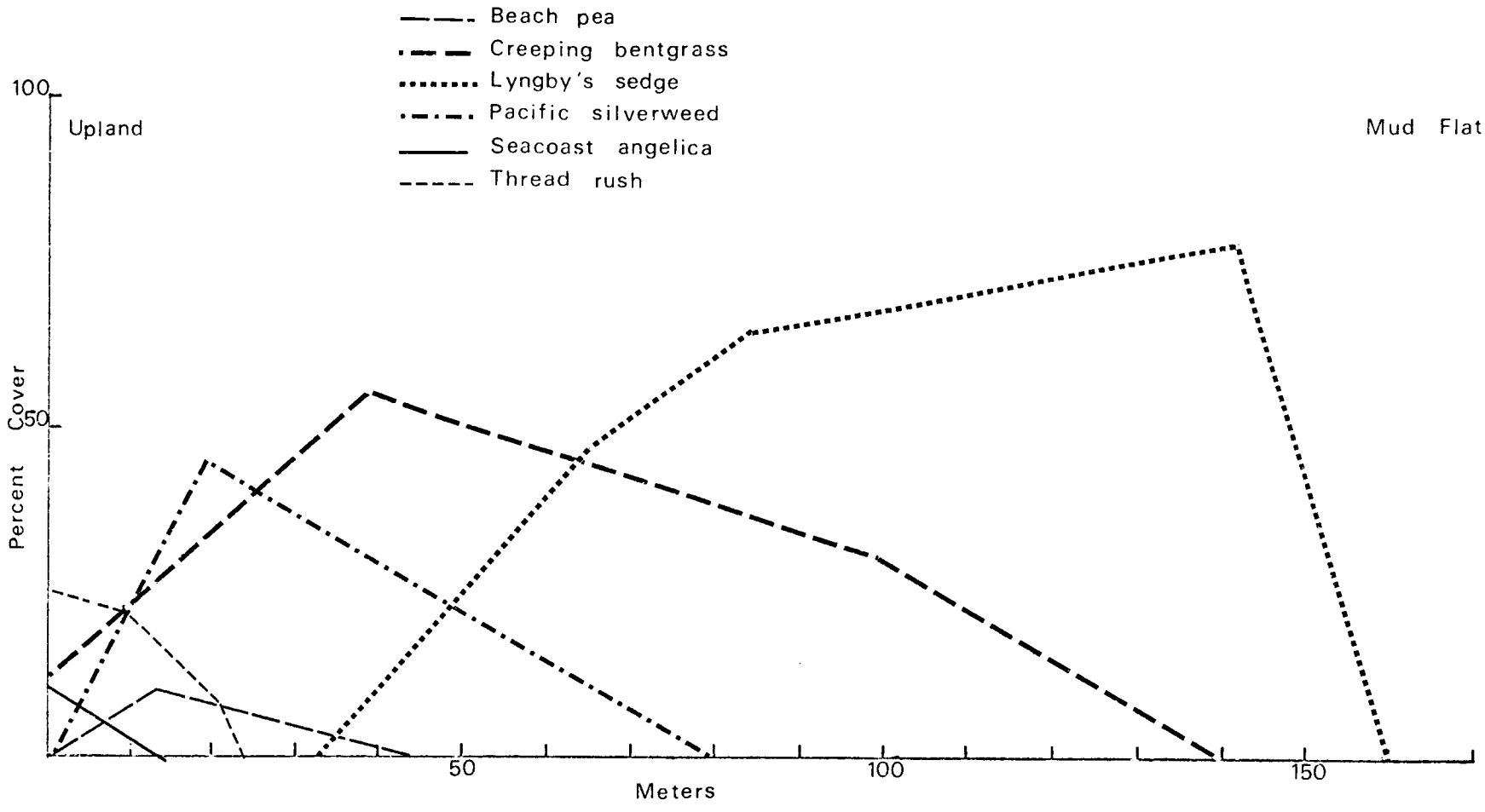

Figure 1. Distribution and coverage of dominant species of plants found in sampling area 2, segment 1.

Sampling area: 3, segment 1

Habitat: Tidal marsh

Location: Oregon shore; RM 7; N.W. ¼ S. 6, T. 8 N., R. 10 W.; Ft. Stevens State Park. The marsh is bounded on the upland edge by sand dunes and scotchbroom and on the lower edge by a steep-banked tidal channel. The sampling area was located on the west bank of the tidal channel.

Size of area: The area sampled was approximately 500 yards long and 40-60 yards wide.

Slope: That portion of the sampling area from the tidal channel to near the upland edge had a slope of 1-2 percent. The bank connecting the rather flat portion of the marsh and the upland had a slope of approximately 30 percent.

Aspect: N., N.E. (5°)

Sampling methods: A 0.5 x 0.5 m frame at five meter intervals was used to sample this area. The small sampling frame and short interval were necessary because of the narrow bands of vegetation. Four transects parallel to the elevational gradient were used. Transects were 100 yards apart.

Vegetation: Species of plants found in the sampling area are listed in Table 20. Distribution and coverage of dominant species found on the site are shown in Figure 2.

Due to the steepness of the slope between the upland and the tideflat, the upland, transitional and high marsh species are crowded together in an area 20-30 m wide. The slope connects abruptly with the tidal channel and there is an equally abrupt change from many species to "pure" stands of Lyngby's sedge. The first zone was about 10 m wide and made up about 10 percent of the sampling area. Frequencies of the following upland species were high to moderate in this zone: unidentified #8 (4%)*, coastal strawberry (7%) and northern dune tansy (12%). Yarrow (1%), English plantain (<1%) and seacoast angelica (>1%) were other upland species that had low frequencies in this zone. Common reed (16%) and thread rush (<1%) are transitional species that occurred in this zone.

Within the next 10-20 m band most of the upland species fell out. Common reed (55%) and American vetch (50%) were the dominate species. Their frequency was moderate indicating a patchy distribution. Creeping bentgrass (10%) and Pacific silverweed (3%) were present but not well established at this level. Hemlock parsley (15%), great northern aster (11%), cutgrass (5%), Pacific bedstraw (<1%), false brome (<1%) were also growing in this area in small numbers.

Creeping bentgrass (75%) dominated the next band which also covered about 10 percent of the sample area and was 10-20 m wide. The zone began at a distance of 10-30 m from the beginning of the sample area. The percent cover of great northern aster (30%) increased while its frequency remained

*Denotes percent cover unless otherwise specified.

moderately high. The percent cover for American vetch (20%) decreased as well as its frequency value. This zone changed abruptly into a pure stand of Lyngby's sedge (97%) which covers 70 percent of the sample area. The zone is 40-60 m wide and begins 20-40 m out along the gradient. The zone ends at the tidal channel where a few unrecorded plants of tufted hairgrass were growing.

Table 20. Plants identified in sampling area 3 (tidal marsh), segment 1.

Yarrow
Creeping bentgrass
Seacoast angelica
Great northern aster
False brome
Lyngby's sedge
Hemlock parsley
Coastal strawberry
Pacific bedstraw
Thread rush
Cutgrass
Common reed
English plantain
Pacific silverweed
Northern dune tansy
American vetch

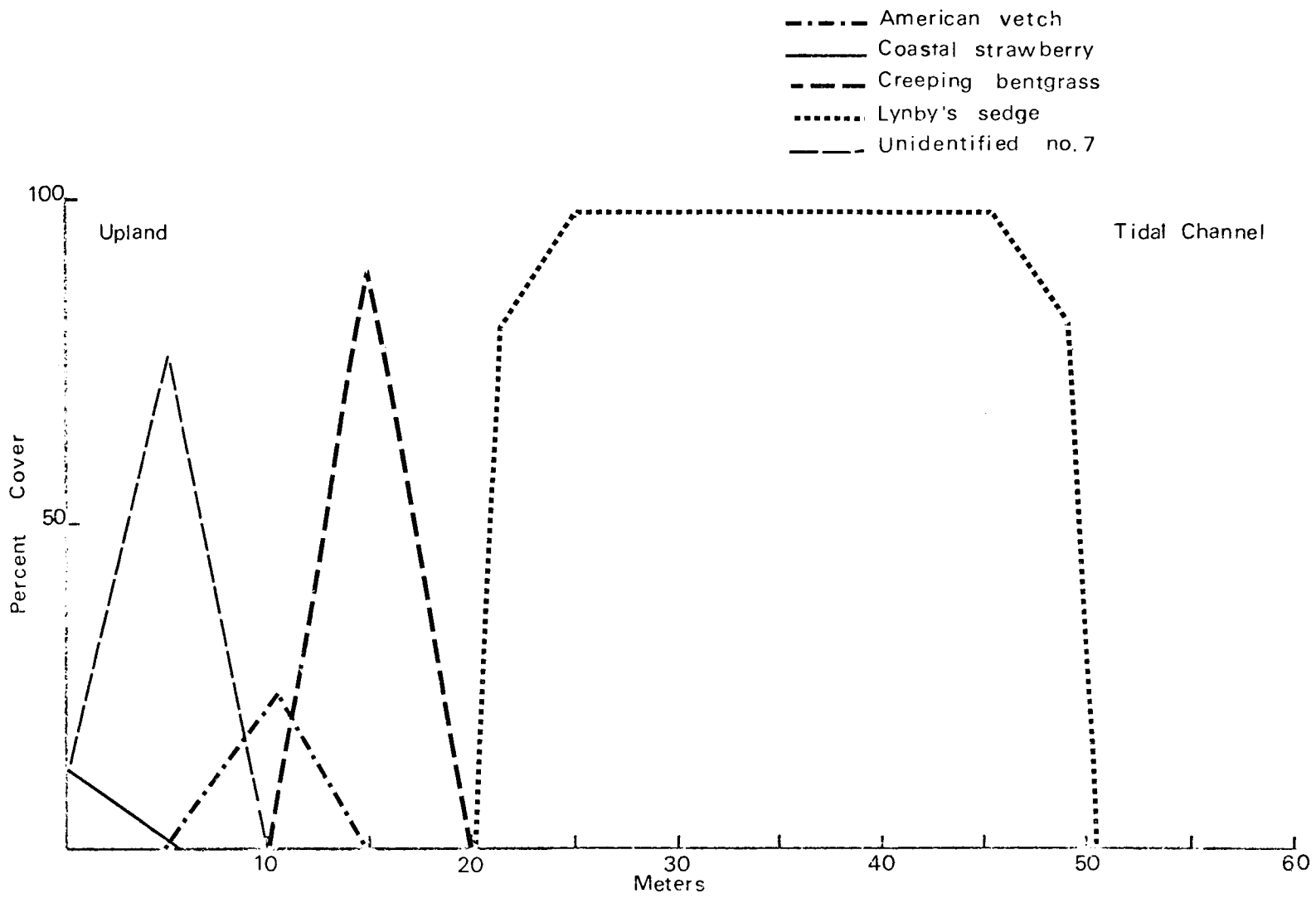

Figure 2. Distribution and coverage of dominant species of plants found in sampling area 3, segment 1.

Sampling area: 4, segment 1

Habitat: Alder (red alder / Lyngby's sedge)

Location: Oregon shore; RM 7; W. ½ S. 6, T. 8 N., R. 10 W.; Ft. Stevens State Park. The stand is bordered by stabilized sand on the west (scotch broom and beachgrass), and a bike path on the north, east, and south edges.

Size of area: Approximately 400 yards long by 75 yards wide

Slope: None

Aspect: None

Elevation: Near sea level

Soil: Sandy, covered by greater than 3 inches of peat.

Vegetation: Red alder, Hooker's willow, Pacific willow, and Sitka spruce, listed in decreasing importance, comprise the canopy (Table 21). Swamp crabapple and Pacific serviceberry were noted in the stand but were not recorded within the study plots.

Hooker's willow was the only shrub occurring in sampling plots. Fallen branches which rooted account for the presence of the willow shrubs. Salmonberry, trailing blackberry, and twinberry are other shrubs dispersed throughout the sampling area.

Lyngby's sedge dominates the herbaceous layer of the stand (Table 21). Soft chess, cleavers, and sword fern occur in the stand but did not occur in the sample plots.

Ground coverage: Litter 94 percent, live vegetation 6 percent

Table 21. Vegetative composition of intensive sampling area 4 (alder), segment 1.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Red alder	tree	100	--	70	51	5	--	--	--
Hooker's willow	tree	40	--	17.5	35	4	--	--	--
Pacific willow	tree	10	--	7.5	52	9	--	--	--
Sitka spruce	tree	20	--	5	31	5	--	--	--
Pacific serviceberry[3]	tree	--	--	--	--	--	--	--	--
Western crabapple[3]	tree	--	--	--	--	--	--	--	--
For all trees[1]	--	--	--	--	42	--	483	9.6	90.3
Salmonberry[3]	shrub	--	--	--	--	--	--	--	--
Twinberry[3]	shrub	--	--	--	--	--	--	--	--
Wild trailing blackberry[3]	shrub	--	--	--	--	--	--	--	--
Lyngby's sedge	forb	55	6.2	--	--	--	--	--	--
Cleavers[3]	forb	--	--	--	--	--	--	--	--
Sword fern[3]	forb	--	--	--	--	--	--	--	--
Soft chess[3]	grass	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 5, segment 1

Habitat: Beachgrass

Location: Washington shore; RM 1; Fort Canby State Park. Sandy beach borders the sample area on the north and west, the south jetty on the south, and coast pine and scotch broom to the east.

Size of area: The stand of beachgrass is approximately one mile long and 100-200 yards wide.

Slope: None--area has a rolling dune appearance.

Aspect: None

Elevation: Near sea level

Soil: Sand

Vegetation: Beachgrass is the dominant species of the stand. Other common forbs and grasses, listed in order of decreasing basal area cover values are: six-week fescue, coastal strawberry, Oregon sedum, hairy cats-ear, and soft chess (Table 22).

No shrubs or trees occur in the sample area.

Ground coverage: Litter 52 percent, bare ground 42 percent, and live vegetation 6 percent

Table 22. Vegetative composition of intensive sampling area 5 (beachgrass), segment 1.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[1] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[1] AREA (ft)
Beach pea	forb	20	0.05	--	--	--	--	--	--
Coastal strawberry	forb	85	0.85	--	--	--	--	--	--
Oregon sedum	forb	45	0.55	--	--	--	--	--	--
Red dock	forb	75	0.4	--	--	--	--	--	--
False dandylion	forb	60	0.55	--	--	--	--	--	--
English plantain	forb	15	0.25	--	--	--	--	--	--
Seashore lupine	forb	50	0.45	--	--	--	--	--	--
Epilobium spp.	forb	15	0.4	--	--	--	--	--	--
Mouse-ear chickweed	forb	5	0.05	--	--	--	--	--	--
Yarrow[2]	forb	--	--	--	--	--	--	--	--
Cleavers[2]	forb	--	--	--	--	--	--	--	--
Small cleavers[2]	forb	--	--	--	--	--	--	--	--
American glehnia[2]	forb	--	--	--	--	--	--	--	--
Yellow sand verbena[2]	forb	--	--	--	--	--	--	--	--
Sword fern[2]	forb	--	--	--	--	--	--	--	--
Western bracken fern[2]	forb	--	--	--	--	--	--	--	--
Salt rush[2]	forb	--	--	--	--	--	--	--	--
Carex spp.[2]	forb	--	--	--	--	--	--	--	--
Veronica chamaedrys[2]	forb	--	--	--	--	--	--	--	--
Beachgrass	grass	75	1.55	--	--	--	--	--	--
Soft chess	grass	60	0.45	--	--	--	--	--	--
Six-weeks fescue	grass	65	0.95	--	--	--	--	--	--
Seashore brome	grass	5	0.1	--	--	--	--	--	--
Kentucky bluegrass[2]	grass	--	--	--	--	--	--	--	--

[1]Basal area for forbs, canopy cover for trees and shrubs.
[2]Species was present in stand but did not occur in sample plots.

Sampling area: 6, segment 1

Habitat: Alder (red alder / Lyngby's sedge)

Location: Washington shore; RM 2; Fort Canby State Park. The stand is bordered on the north by coniferous forest; on the west and south by beachgrass, scotch broom, and coast pine; and the east by a camping area and lake.

Size of area: The stand is approximately 600-700 yards long and 100-200 yards wide.

Slope: None

Aspect:

Elevation: Near sea level

Soil: Organic matter and peat to 7 inches

Vegetation: The canopy is primarily red alder (96 percent cover) and Hooker's willow (3 percent cover) having an average height of 63 and 29 feet, respectively (Table 23). Sitka spruce, swamp crabapple, and coast red elder occur sparingly throughout the stand.

Shrubs are not prominent in the understory, although salmonberry, twinberry, and Pacific willow are all present (Table 23).

Lyngby's sedge dominates the herbaceous understory. Sword fern, western bracken fern, cleavers, candy flower, and cow parsnip occur in the study area.

The only grass observed within the alder-sedge habitat was soft chess.

Ground coverage: Litter 91 percent, live vegetation 9 percent

Table 23. Vegetative composition of intensive sampling area 6 (alder), segment 1.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Red alder	tree	100	--	70	63	6	--	--	--
Hooker's willow	tree	40	--	17.5	29	4	--	--	--
Western crabapple	tree	20	--	2.5	20	3	--	--	--
Sitka spruce	tree	10	--	5	11	3	--	--	--
Coast red elder	tree	10	--	2.5	22	3	--	--	--
For all trees[1]	--	--	--	--	29	4	335	11.4	130
Pacific willow[3]	shrub	--	--	--	--	--	--	--	--
Pacific serviceberry[3]	shrub	--	--	--	--	--	--	--	--
Salmonberry[3]	shrub	--	--	--	--	--	--	--	--
Evergreen blackberry[3]	shrub	--	--	--	--	--	--	--	--
Lyngby's sedge	forb	90	9	--	--	--	--	--	--
Sword fern[3]	forb	--	--	--	--	--	--	--	--
Western bracken fern[3]	forb	--	--	--	--	--	--	--	--
Cleavers[3]	forb	--	--	--	--	--	--	--	--
Baneberry[3]	forb	--	--	--	--	--	--	--	--
Candy flower[3]	forb	--	--	--	--	--	--	--	--
Cow parsnip[3]	forb	--	--	--	--	--	--	--	--
Equisetum spp.[3]	forb	--	--	--	--	--	--	--	--
Bog stitchwort[3]	forb	--	--	--	--	--	--	--	--
Coast strawberry[3]	forb	--	--	--	--	--	--	--	--
Deer fern[3]	forb	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 7, segment 1

Habitat: Tidal marsh

Location: Washington shore; RM 2; Ft. Canby State Park. Bordered on the upland side by a steep, forested slope of red alder and on the lower side by mud flat.

Size of area: The sampling area was 400 yards long and 80-150 yards wide. The marsh which contains the sampling area is approximately 700 yards long.

Slope: From <5 percent near the lower edge to about 10 percent at the upper edge.

Aspect: E., S.E. (100°)

Sampling methods: Sampling was done with a 1 x 1 m frame at 10 m intervals along four parallel transects 100 yards apart. Transects were parallel to the elevational gradient.

Vegetation: Species of plants found in the sampling area are listed in Table 24. Distribution and coverage of dominant species in the area are shown in Figure 3.

In general the vegetation of this area graded from immature intertidal marsh, through sedge and three-square bulrush communities. An aerial view of the marsh shows continuous vegetative cover (except for tide channels) dominated primarily by Lyngby's sedge from the edge of the woods to a distance of about 80 m on the east side and 50-60 m on the west. A less dense section dominated by three-square bulrush (30%)* extends another 60-80 m on the eastern half. The visual character of the upper section of the marsh is one of greater species richness with a Lyngby's sedge (33%) dominated matrix. Between this area and the relatively pure stands of Lyngby's sedge (90%) a band codominated by Pacific silverweed (23%) and Lyngby's sedge (33%) is particularly conspicuous. It varies in width from 50 m on the east side to 10 m on the west. A patch of lesser cat-tail is also visible on the west side at a freshwater outlet.

The transects started within 15 m of the alder woods. An abrupt transition in vegetation types resulted in few upland species, other than hedge bindweed showing up in the first set of plots. Low frequency values recorded for Pacific water-parsley (12%), beaked spike-rush (6%), springbank clover (3%), and western water-hemlock (2%) indicate that these common visual dominants of mature intertidal marsh are presently colonizing the upper fifty feet of the sample area. Although it was only recorded on one transect, birdsfoot-trefoil (70%), an introduced European species, may become a problem at Ft. Canby as it has at Gray's Bay. Lyngby's sedge (33%) is the most abundant species. Cutgrass (1%), common reed (<1%), thread rush (<1%), silverweed (5%) and bentgrass (1%) are other freshwater intertidal marsh species present in low numbers. Seaside arrow-grass (3%), three-square bulrush (7%) and lilaeopsis (<1%) occur here but are better represented lower in the profile. They are probably remnant individuals from an earlier stage of succession when three-square may have dominated the area.

*Denotes percent cover unless otherwise specified.

In the section codominated by Pacific silverweed (23%) and Lyngby's sedge (33%), creeping bentgrass starts to be an important species also. It occurred in a majority of the plots and had vegetative cover values as high as 20 percent. Tufted hairgrass (3%), paint-brush owl-clover (<1%), beach pea (3%) and small spike-rush (2%), additional species found in more mature intertidal marshes are present in small numbers. The species mentioned above (arrow-grass, three-square, etc.) also occur here with moderate frequency and low cover values. The substrate in this area was siltier, with more incorporated organic material from the higher litter levels, than that found nearer the water. This vegetation type occurs in about one fourth of all the sample plots.

The zone dominated by Lyngby's sedge (90%) contains few other species. Only scattered individuals of creeping bentgrass and lesser cat-tail were recorded. Lilaeopsis was also found here but never in large numbers, possibly because the high density of sedge does not allow enough light to penetrate to these small plants. The vegetative parts of the sedge were very healthy, averaging twelve decimeters in length. Reproductive parts seemed to be absent for the most part. Reproduction of this species is inferred to be vegetative. About one quarter of plots sampled had cover values for Lyngby's sedge of 80-100 percent. Another quarter of the plots had values of about 60 percent but were not substantially different from the higher density sedge dominated plots in any other respect. These plots either occurred between the higher density area and that dominated by three-square bulrush at tide channels or where the sedge zone extended to the low-tide water level.

The pure stand of three-square bulrush represents the initial colonization of the low sandy section of the marsh. Concentration of this community type on the east side probably means that sandy conditions still exist there but do not on the western side. Cover values for this species vary from 10-70 percent and average 37 percent.

Table 24. Plants identified in sampling area 7 (tidal marsh), segment 1.

Creeping bentgrass
Lyngby's sedge
Western water-hemlock
Tufted hairgrass
Small spike-rush
Beaked spike-rush
Thread rush
Beach pea
Cutgrass
Lilaeopsis
Birdsfoot-trefoil
Pacific water-parsley
Paint-brush owl-clover
Common reed
Pacific silverweed
Three-square bulrush
Springbank clover
Seaside arrow-grass
Lesser cat-tail

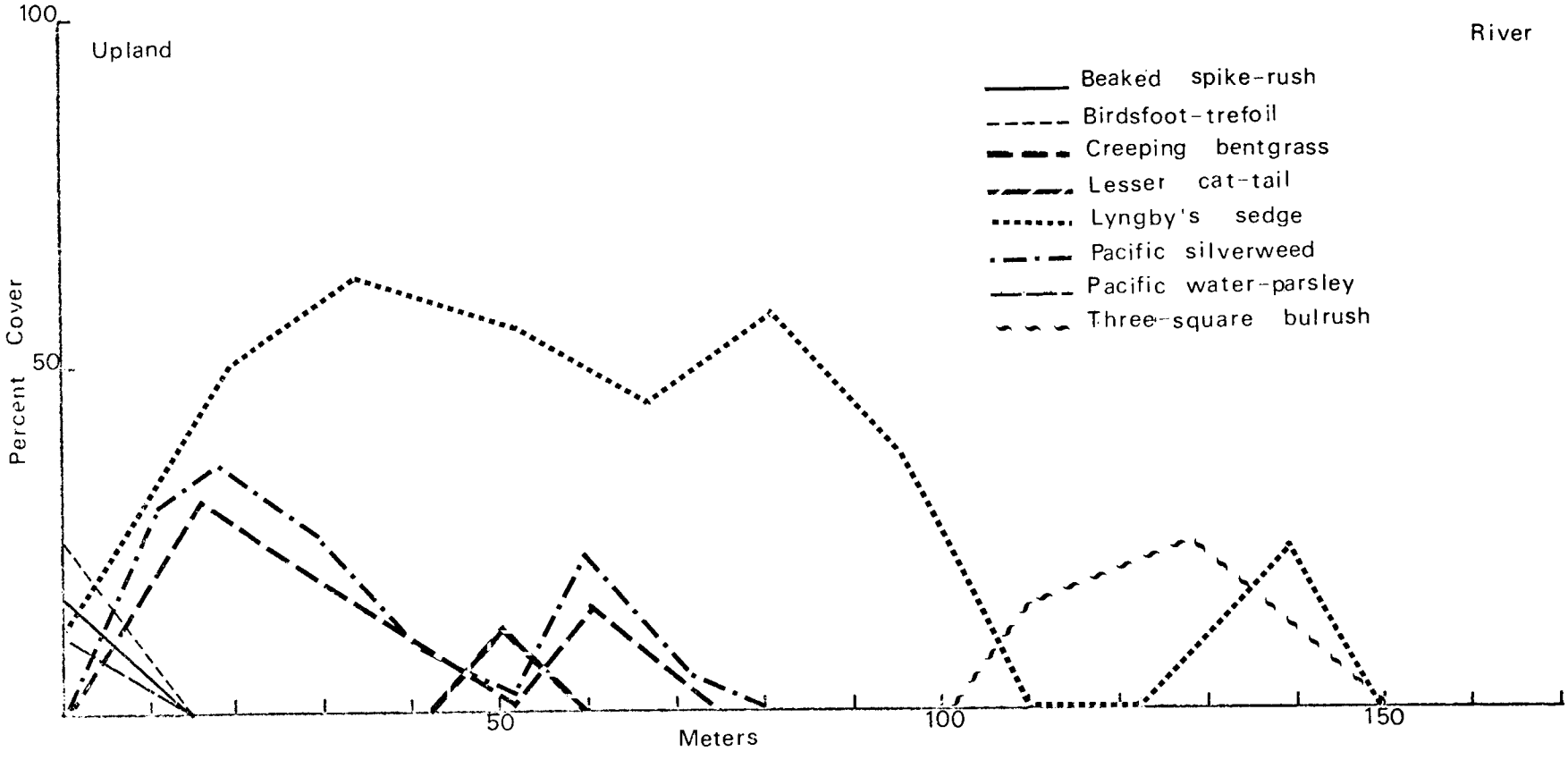

Figure 3. Distribution and coverage of dominant species of plants found in sampling area 7, segment 1.

Sampling area: 1, segment 2

Habitat: Tidal marsh

Location: Oregon shore; RM 21; N.E. ¼ S. 20 and S.W. ¼ S. 16, T. 8 N., R. 8 W. This marsh is bounded on the east, south, and west by a stand of Sitka spruce/willow and on the north by the South Channel of the Columbia R. Eskeline Creek drains into the marsh from the southwest. A railroad (RR) divides the marsh into north and south parts.

Size of area: The marsh is approximately 1000 x 200-300 yards in size.

Slope: Near zero

Aspect: None

Sampling methods: The marsh was sampled as a homogenous stand because there was essentially no elevational gradient and no obvious zonation of vegetation. A sampling frame 1 x 1 m in size was used at 10 m intervals along a single transect. The transect extended from the southern edge of the marsh, at the edge of the spruce/willow stand, in a northeast direction across the RR to the South Channel.

Vegetation: Species of plants found in the sampling area are listed in Table 25. Distribution and coverage of dominant species found in the north and south parts of the sampling area are shown separately in Figures 4 and 5.

Areas within the sampling area were dominated by marsh horsetail, Lyngby's sedge, and common cat-tail separately. The patchiness of these species probably resulted from differences in time of colonization, the freshwater influence of the creek, and the selective feeding habits of nutria. According to a resident of Burnside, Oregon, common cat-tail covered most of the marsh several years ago. It is now limited to a medium-sized patch in the south-east part of the marsh near the railroad grade. This man believed nutria had killed the cat-tail through feeding on roots and stems.

The total number of species south of the railroad was about twice that found north of it. Among those present on the south side and not on the north were: common cat-tail, skunk cabbage and Pacific silverweed. All of these species prefer relatively sheltered areas of low salinity, which may account for their distribution in the sample area if the construction of the railroad grade altered the environmental conditions of the marsh, making the south side more sheltered and less saline than the northern one. Although very low in frequency on the south side, the following plants were either of much lower frequency or absent from the north side as indicated by the failure to record presence in any sample plots on the north side: nodding beggars-tick, beaked spike-rush, rough bugleweed, field mint, Bergamont mint, small-flowered forget-me-not, dwarf alkaligrass, and unidentified #1. Another explanation for the difference in species composition between the two sections is age. The south side was probably colonized first, in which case its vegetation has reached a stage of greater maturity. The fact that a few remaining individuals of seacoast bulrush--an early marsh colonizer--were recorded north of the railroad supports this explanation.

Small-fruited bulrush forms a band of vegetation between the woods and the marsh area sampled. The vegetation shifts abruptly from this species to an area where many species are present but where there are no clear dominants. Lyngby's sedge (20%)* and skunk cabbage (10%) were the most prominent species in this area. Other species, with less than 10 percent cover values, were found in this section as well as scattered throughout the sample area. There were generally fewer of these species recorded for plots with high densities of either Lyngby's sedge or common cat-tail. In terms of these low density species, the next section of the sample area was fairly uniform, however the visual character of the area was determined by the three dominant species. These were in order of number of plots dominated by each, marsh horsetail, Lyngby's sedge and common cat-tail. Softstemmed bulrush occurred as a codominant in the area sampled and as a dominant outside the sampling transect. Fifty percent of the plots sampled were dominated by marsh horsetail with percent cover varying from 20-100 percent. Approximately 20 percent of the plots sampled were codominated by marsh horsetail (40%) and Lyngby's sedge (50%). Lyngby's sedge (90%) occurred as the dominant species in about 13 percent of the plots. This number does not accurately indicate the extent of the area dominated by this species because the area north of the tide channel which was entirely covered by this species was not sampled. The stand of common cat-tail is also under-represented in this respect; due to the difficulty of sampling and the apparent homogeneity of species and density, only a few plots were taken in the cat-tail stand. Of the more minor species, Pacific water-parsley (5%) had the highest frequency. Yellow monkey-flower (2%), deer-cabbage (3%), skunk cabbage (5%) and waterpepper all had moderate frequency values. Frequencies for American waterplantain (3%), wapato (1%), Watson's willow-weed (5%), cutgrass (<1%), silverweed and beaked spike-rush were low.

*Denotes percent cover unless otherwise specified.

Table 25. Plants identified in sampling area 1 (tidal marsh), segment 2.

American waterplantain
Nodding beggars-tick
Lyngby's sedge
Western water-hemlock
Beaked spike-rush
Watson's willow-weed
Marsh horsetail
Cutgrass
Rough bugleweed
Skunk cabbage
Field mint
Bergamont mint
Yellow monkey-flower
Small-flowered forget-me-not
Deer-cabbage
Pacific water-parsley
Waterpepper
Pacific silverweed
Wapato
Seacoast bulrush
Small-fruited bulrush
Softstem bulrush
Great duckweed
Common cat-tail

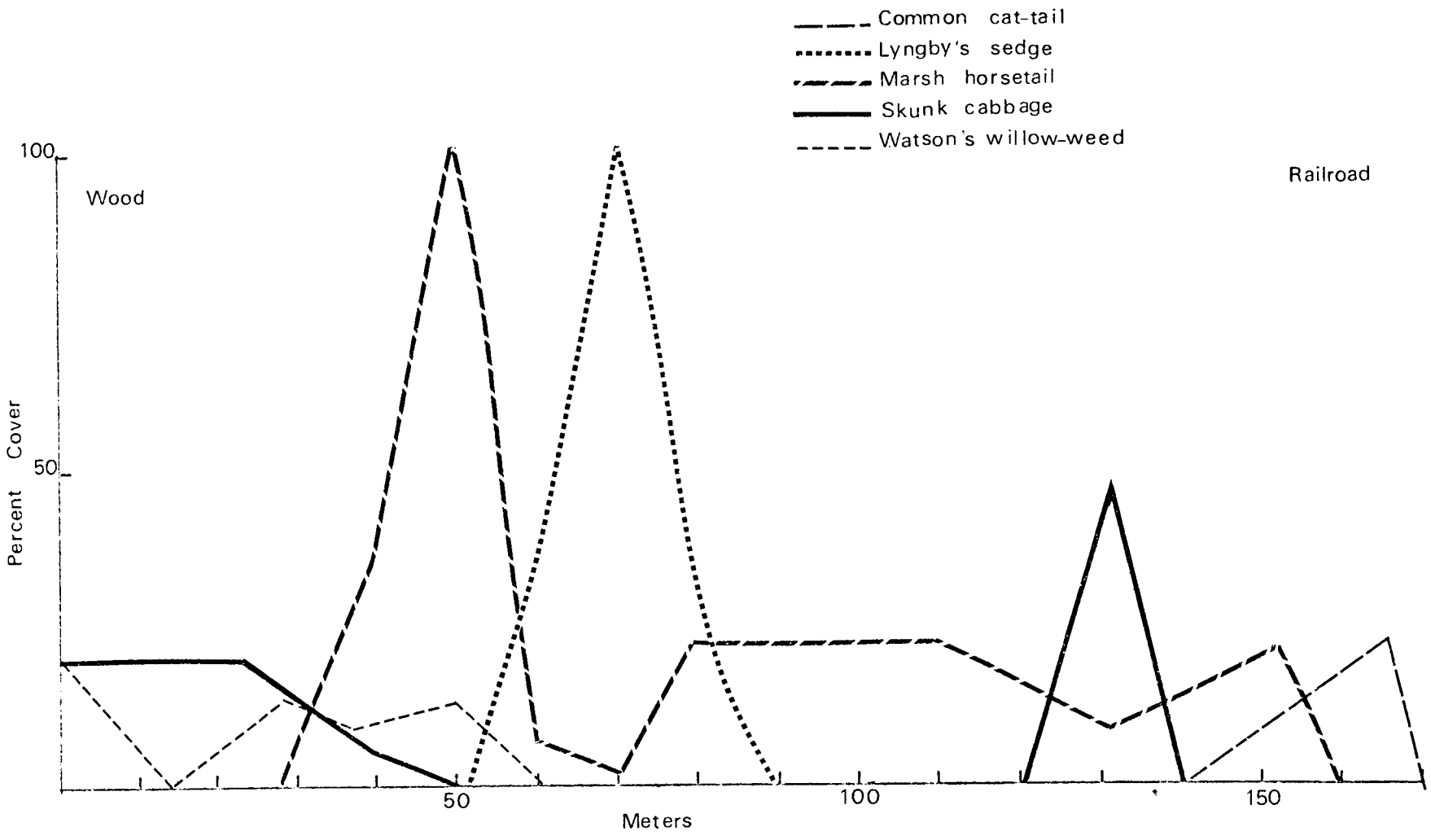

Figure 4. Distribution and coverage of dominant species of plants found in the southern part of sampling area 1, segment 2.

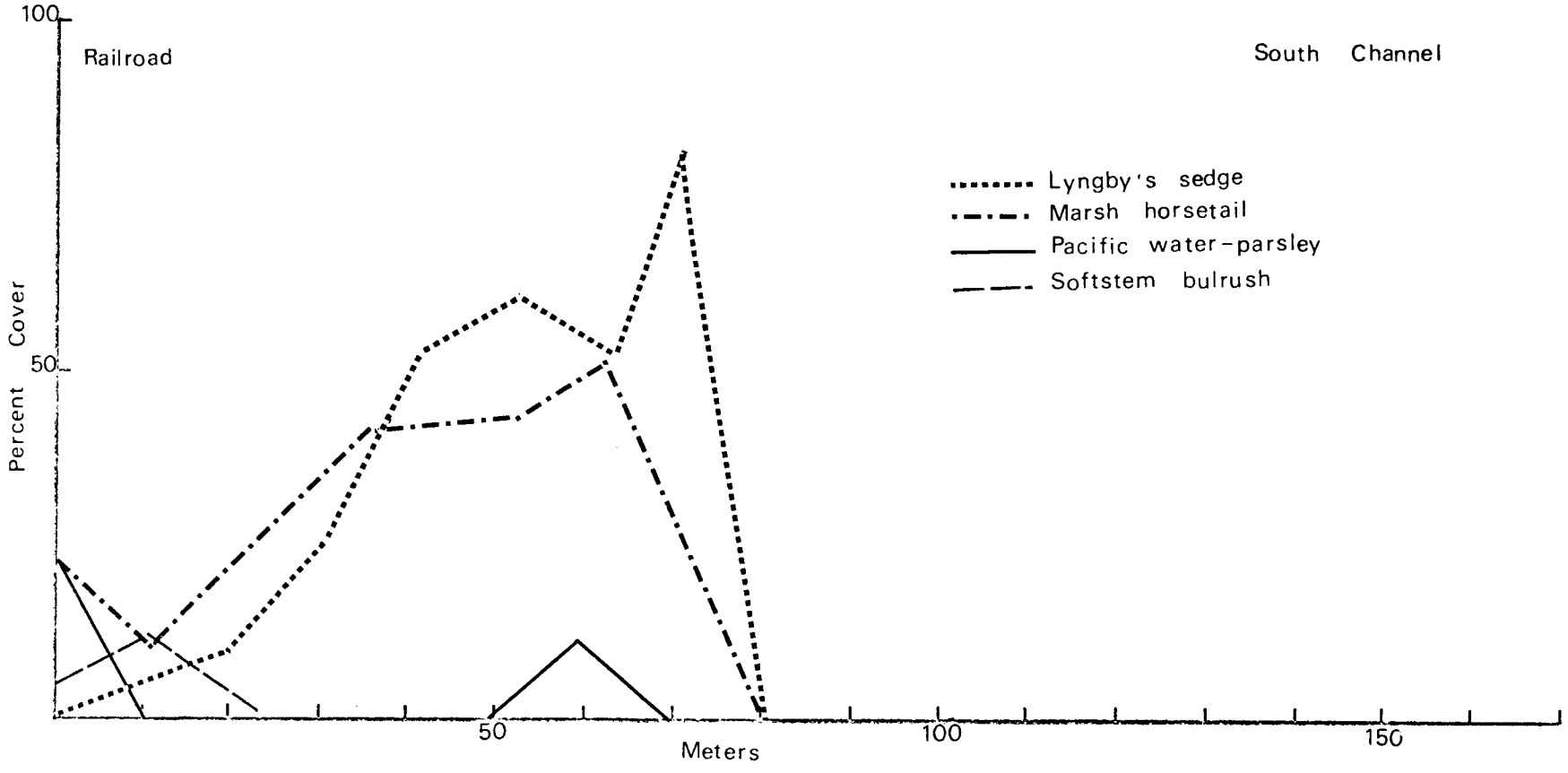

Figure 5. Distribution and coverage of dominant species of plants found in the northern part of sampling area 1, segment 2.

Sampling area: 2, segment 2

Habitat: Tidal shrub willow (Hooker's willow / western bracken fern)

Location: Oregon shore; RM 25; S.E. ¼ S. 12, T. 8 N., R. 8 W. The stand is bordered on the east and west by tidal marsh. Railroad tracks mark the southern edge. Knappa Slough runs along the north edge of the stand.

Size of area: Approximately 100 yards by 200 yards

Slope: None

Aspect: None

Elevation: Near sea level

Soil: Sandy soil mixed with high quantities of organic matter to about 3 inches.

Vegetation: Hooker's and Pacific willow with average heights of 24 and 26 feet respectively dominate the canopy of the stand. They also dominate the shrub understory. Western dogwood, twinberry, and Pacific serviceberry are other shrubs that appear frequently in the stand. Mean height of all shrubs was 13 feet.

Western bracken fern had the greatest basal area cover of the herbaceous understory species (Table 26). The bracken ferns were approximately 3 feet in height.

Other species occurring in the stand, listed in order of decreasing basal area coverage, were skunk cabbage, softstem bulrush, orange balsam, peach peavine, common cat-tail, and chain speedwell.

Tidal channels from 1-3 feet deep were present throughout the stand.

Ground coverage: Live vegetation 5 percent, litter 95 percent

Table 26. Vegetative composition of intensive sampling area 2 (tidal shrub willow), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Hooker's willow	tree	60	--	50	24	3	--	--	--
Pacific willow	tree	80	14	50	26	4	--	--	--
Western hemlock[3]	tree	--	--	--	--	--	--	--	--
For all trees[1]	--	--	--	--	25	3	433	10.03	101
Hooker's willow	shrub	60	56	--	20	--	230	--	--
Pacific willow	shrub	40	15	--	14	--	140	--	--
Creek dogwood	shrub	50	10	--	7	--	110	--	--
Twinberry	shrub	20	3	--	10	--	30	--	--
Pacific serviceberry	shrub	10	--	--	6	--	20	--	--
Salal[3]	shrub	--	--	--	--	--	--	--	--
Salmonberry[3]	shrub	--	--	--	--	--	--	--	--
Wood rose[3]	shrub	--	--	--	--	--	--	--	--
Ninebark[3]	shrub	--	--	--	--	--	--	--	--
Western bracken fern	forb	75	1.15	--	--	--	--	--	--
California false hellebore	forb	5	0.05	--	--	--	--	--	--
Skunk cabbage	forb	25	0.65	--	--	--	--	--	--
Common cat-tail	forb	5	0.05	--	--	--	--	--	--
Beach pea	forb	5	0.05	--	--	--	--	--	--
Orange balsam	forb	55	0.2	--	--	--	--	--	--
Softstem bulrush	forb	25	0.3	--	--	--	--	--	--
Sword fern[3]	forb	--	--	--	--	--	--	--	--
Arrowleaf groundsel[3]	forb	--	--	--	--	--	--	--	--
Slough sedge[3]	forb	--	--	--	--	--	--	--	--
Equisetum spp.[3]	forb	--	--	--	--	--	--	--	--
Maidenhair fern[3]	forb	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 3, segment 2

Habitat: Sitka spruce (Sitka spruce--red alder / salmonberry / mosses)

Location: Oregon shore; RM 26; N.E. ¼ S. 18, T. 8 N., R. 7 W. The stand is bordered on the north by Knappa Slough and all other sides by upland coniferous forest of hemlock, Douglas fir, western red cedar primarily.

Size of area: Approximately 1,000 yards by 750 yards

Slope: None

Aspect: None

Elevation: Near sea level

Soil: Clay, mixed with a large amount of peat

Vegetation: Sitka spruce and red alder co-dominate the stand. Sitka spruce has superior height (average height 108 feet) and trunk diameter (average dbh 22 inches) compared to 52 feet average height and 9 inches average dbh for red alder. Red alder has a greater percent cover, however (Table 27). Hooker's willow, Pacific willow, western red cedar, and vine maple were other common trees in the stand.

Shrubs are very dense and together with fallen trees constructs a nearly impenetrable understory. Salmonberry has the highest density. Salal, wild rose, thimbleberry, coast red elder, and wild trailing blackberry are among the more numerous shrubs located throughout the stand (Table 27).

Moss covers most (82 percent of vegetative cover) of the ground and litter. Other forbs, listed in order of decreasing basal area cover are skunk cabbage, slough sedge, western bracken fern, and wild succory.

Ground coverage: Litter 65 percent, bare ground 30 percent and live vegetation 5 percent

Table 27. Vegetative composition of intensive sampling area 3 (Sitka spruce), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Hooker's willow	tree	10	4	2	42	5	--	--	--
Red alder	tree	70	73	32	52	9	--	--	--
Pacific willow	tree	20	10	5	36	3	--	--	--
Sitka spruce	tree	70	63	32	108	22	--	--	--
Western red cedar	tree	40	--	10	53	12	--	--	--
Vine maple	tree	30	--	7	25	2	--	--	--
Coast red elder	tree	10	--	2	24	4	--	--	--
Big-leaf maple	tree	10	--	2	89	14	--	--	--
For all trees	--	--	--	--	57	13	96	21.4	456
Wood rose	shrub	20	3	--	5	--	90	--	--
Thimbleberry	shrub	20	12	--	6	--	50	--	--
Salmonberry	shrub	60	49	--	5	--	340	--	--
Ninebark	shrub	20	16	--	4	--	10	--	--
Hooker's willow	shrub	30	12	--	15	--	30	--	--
Creek dogwood	shrub	50	22	--	15	--	30	--	--
Wild trailing blackberry	shrub	10	--	--	2	--	40	--	--
Coast red elder	shrub	20	--	--	3	--	50	--	--
Salal	shrub	20	22	--	4	--	130	--	--
Twinberry[3]	shrub	--	--	--	--	--	--	--	--
Blue bindweed[3]	shrub	--	--	--	--	--	--	--	--
Snowberry[3]	shrub	--	--	--	--	--	--	--	--
Mosses	forb	30	82	--	--	--	--	--	--
Slough sedge	forb	15	6	--	--	--	--	--	--
Western bracken fern	forb	20	3	--	--	--	--	--	--
Poison hemlock	forb	10	1	--	--	--	--	--	--
Skunk cabbage	forb	25	8	--	--	--	--	--	--
Deer fern[3]	forb	--	--	--	--	--	--	--	--
Sword fern[3]	forb	--	--	--	--	--	--	--	--
Purple beach pea[3]	forb	--	--	--	--	--	--	--	--
Western buttercup[3]	forb	--	--	--	--	--	--	--	--
Wood trillium[3]	forb	--	--	--	--	--	--	--	--
Maidenhair fern[3]	forb	--	--	--	--	--	--	--	--
Equisetum spp.[3]	forb	--	--	--	--	--	--	--	--
Swamp bedstraw[3]	forb	--	--	--	--	--	--	--	--

Table 27. Continued.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Arrowleaf groundsel[3]	forb	--	--	--	--	--	--	--	--
Fringe cup[3]	forb	--	--	--	--	--	--	--	--
Foxglove[3]	forb	--	--	--	--	--	--	--	--
Orange balsam[3]	forb	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 4, segment 2

Habitat: Cottonwood (black cottonwood / creek dogwood / equisetum)

Location: Oregon shore; RM 65; N.E. ¼ S. 18, T. 8 N., R. 7 W. Sand beach borders the stand to the north and west, railroad tracks form the southern boundary, and dredge spoil marks the eastern edge.

Size of area: Approximately 1,000 yards by 100 yards

Slope: None

Aspect: None

Elevation: 15.0-27.0 feet

Soil: Sandy, much of which is dredge spoil.

Vegetation: Black cottonwood dominates the forested layer of the community. The cottonwoods average 108 feet in height and 11 inches dbh. Pacific willow also occurs in the stand and has an average height of 47 feet.

Of the shrubs occurring in the sample area, creek dogwood has the greatest canopy coverage and density (Table 28). Several shrub species present in the stand did not occur in randomized sample plots because of their low cover values and patchy distribution. Snowberry and Himalayan berry are the most numerous of these shrubs (Table 28).

The herbaceous understory is very diverse. Dredge spoil, which is prominent in the area, probably accounts for this diversity. Equisetum dominates the herbaceous undergrowth. Other forbs located within the plots (Table 28) are spread sparingly throughout the stand.

Ground coverage: Litter 96 percent, bare ground 1 percent, live vegetation 3 percent

Table 28. Vegetative composition of intensive sampling area 4 (cottonwood), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Black cottonwood	tree	100	100	90	108	11	--	--	--
Pacific willow	tree	30	--	10	47	8	--	--	--
For all trees[1]	--	--	--	--	102	11	187	15.20	231
Creek dogwood	shrub	90	94	--	11	--	330	--	--
Wild trailing blackberry	shrub	--	10	--	1	--	340	--	--
Black cottonwood	shrub	--	10	--	13	--	70	--	--
Coast black gooseberry[3]	shrub	--	--	--	--	--	--	--	--
Himalayan berry[3]	shrub	--	--	--	--	--	--	--	--
Evergreen blackberry[3]	shrub	--	--	--	--	--	--	--	--
Coast red elder[3]	shrub	--	--	--	--	--	--	--	--
Snowberry[3]	shrub	--	--	--	--	--	--	--	--
Equisetum spp.	forb	85	1.55	--	--	--	--	--	--
Mosses	forb	5	0.25	--	--	--	--	--	--
Hairy vetch	forb	5	0.05	--	--	--	--	--	--
Stinging nettle	forb	5	0.05	--	--	--	--	--	--
Northern bedstraw	forb	5	0.05	--	--	--	--	--	--
Sword fern	forb	5	0.05	--	--	--	--	--	--
Brass buttons	forb	5	0.05	--	--	--	--	--	--
Annual fleabane[3]	forb	--	--	--	--	--	--	--	--
Fireweed[3]	forb	--	--	--	--	--	--	--	--
Wooly clover[3]	forb	--	--	--	--	--	--	--	--
Small hop clover[3]	forb	--	--	--	--	--	--	--	--
Inside-out flower[3]	forb	--	--	--	--	--	--	--	--
Tansy ragwort[3]	forb	--	--	--	--	--	--	--	--
Oxeye daisy[3]	forb	--	--	--	--	--	--	--	--
Red clover[3]	forb	--	--	--	--	--	--	--	--
Canadian thistle[3]	forb	--	--	--	--	--	--	--	--
St. John's wort[3]	forb	--	--	--	--	--	--	--	--
False dandylion[3]	forb	--	--	--	--	--	--	--	--
Mullein[3]	forb	--	--	--	--	--	--	--	--
English plantain[3]	forb	--	--	--	--	--	--	--	--
Cleavers[3]	forb	--	--	--	--	--	--	--	--

Table 28. Continued.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Western bracken fern[3]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	5	0.05	--	--	--	--	--	--
Early hairgrass[3]	grass	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 5, segment 2

Habitat: Willow (Pacific willow / reed canarygrass)

Location: Oregon shore; RM 71; S.E. ¼ S. 26, T. 7 N., R. 2 W. Sand beach of the river shore bounds the stand to the north, east, and south. A slough forms the western boundary.

Size of area: Approximately 160 yards by 80 yards

Slope: None

Aspect: None

Elevation: 5-10 feet

Soil: Sandy loam in undisturbed areas and sandy in areas of dredge spoil.

Vegetation: Pacific willow and Oregon ash make up the canopy of the study site with 85 and 36 percent coverage respectively. The two species were approximately the same size, giving the stand a mean tree height of 55 feet (Table 29). Columbia River willow has the highest density value with 40 plants/acre. Pacific willow occurred sparingly in the area.

The understory is composed predominately of herbaceous plants, shrubs are not abundant. Reed canarygrass visually dominates the understory and has a basal area cover value of 0.6 percent. Mosses covered large portions of decaying trees and litter. The most common of the large number of forbs present in the stand are yellow cress, small-flowered forget-me-not, northern bedstraw, field mint, and green dock.

Ground coverage: Live vegetation 2 percent, bare ground 10 percent, litter 88 percent

Table 29. Vegetative composition of intensive sampling area 5 (willow), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Pacific willow	tree	100	85	95	55	9	--	--	--
Oregon ash	tree	20	36	5	54	8	--	--	--
For all trees[1]	--	--	--	--	55	9	198	14.82	220
Pacific willow	shrub	10	1	--	5	--	20	--	--
Columbia River willow	shrub	20	6	--	6	--	40	--	--
Orange balsam	forb	10	0.05	--	--	--	--	--	--
Mosses	forb	10	0.25	--	--	--	--	--	--
Northern bedstraw	forb	20	0.05	--	--	--	--	--	--
Field mint	forb	20	0.05	--	--	--	--	--	--
Blunt-leaved yellow cress	forb	55	0.25	--	--	--	--	--	--
Water-parsley	forb	15	0.05	--	--	--	--	--	--
Small-flowered forget-me-not	forb	20	0.15	--	--	--	--	--	--
Great northern aster	forb	5	0.05	--	--	--	--	--	--
Creeping Charlie	forb	15	0.05	--	--	--	--	--	--
Clustered dock	forb	20	0.05	--	--	--	--	--	--
Yellow cress	forb	5	0.05	--	--	--	--	--	--
Hooker's evening primrose[3]	forb	--	--	--	--	--	--	--	--
Equisetum spp.[3]	forb	--	--	--	--	--	--	--	--
Blue bindweed[3]	forb	--	--	--	--	--	--	--	--
Field milk thistle[3]	forb	--	--	--	--	--	--	--	--
Wild carrot[3]	forb	--	--	--	--	--	--	--	--
Stinging nettle[3]	forb	--	--	--	--	--	--	--	--
Miner's lettuce[3]	forb	--	--	--	--	--	--	--	--
Mouse-ear chickweed[3]	forb	--	--	--	--	--	--	--	--
Foxtail barley	grass	5	0.05	--	--	--	--	--	--
Reed canarygrass	grass	60	0.6	--	--	--	--	--	--
Perennial ryegrass[3]	grass	--	--	--	--	--	--	--	--
Cheatgrass[3]	grass	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 6, segment 2

Habitat: Reed canarygrass (reed canarygrass / slough sedge)

Location: Oregon shore; RM 75; E. ½ S. 13, T. 6 N., R. 2 W. Highway 30 forms the southern extent of the stand. The Spokane, Portland and Seattle Railroad line borders the stand to the north. The west boundary is a stand of willow. The east boundary is grazed pasture.

Size of area: 800 yards by 100 yards

Slope: None

Aspect: None

Elevation: Less than 15 feet

Soil: Water saturated clay; approximately 2 inches of litter on the surface.

Vegetation: At first glance the stand appears to be pure reed canarygrass, about 6 feet tall at maturity. Quantitative sampling revealed that slough sedge, although smaller in size, was nearly as prominent; 1.2 percent cover as compared to 1.6 percent for reed canarygrass. These two species were the only plants present in the sampling plots.

Other forbs observed in the area but not occurring in sample plots were: small-flowered forget-me-not, equisetum, and yellow cress.

Oregon ash trees are growing along the north edge of the stand on the RR grade.

Ground coverage: Live vegetation 3 percent, litter 97 percent

Table 30. Vegetative composition of intensive sampling area 6 (reed canarygrass), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[1] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[1] AREA (ft)
Oregon ash[2]	tree	--	--	--	--	--	--	--	--
Slough sedge	forb	100	1.2	--	--	--	--	--	--
Small-flowered forget-me-not[2]	forb	--	--	--	--	--	--	--	--
Equisetum spp.[2]	forb	--	--	--	--	--	--	--	--
Yellow cress[2]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	100	1.6	--	--	--	--	--	--

[1]Basal area for forbs, canopy cover for trees and shrubs.
[2]Species was present in stand but did not occur in sample plots.

Sampling area: 7, segment 2

Habitat: Cottonwood / willow (black cottonwood / Pacific water-parsley)

Location: Oregon shore; RM 74; N.W. ¼ S. 12; T. 6 N., R. 2 W. The stand is bordered on the north and east by the Columbia River and by Highway 30 on the west. An access road marks the southern boundary.

Size of area: Approximately 300 yards by 75-90 yards

Slope: None

Aspect: None

Elevation: 10-15 feet

Soil: Deep, clay loam

Vegetation: Black cottonwood and Pacific willow were the only species of trees identified on the sampling area (Table 31). Cottonwood has a relative density of 90 percent and is clearly the dominate species of tree. Mean height was 92 feet for cottonwood and 65 feet for willow.

No shrubs occurred in the sample plots even though creek dogwood, blue bindweed, Himalayan berry, thimbleberry, and evergreen blackberry occur in the stand.

Forbs dominate the herbaceous understory. Of these, Pacific water-parsley, creeping Charlie, and stinging nettle have the highest cover values (Table 31). Reed canarygrass occurs throughout the stand and has a cover value of 0.35 percent.

Ground coverage: Live vegetation 3 percent, litter 93 percent, bare ground 4 percent

Table 31. Vegetative composition of intensive sampling area 7 (cottonwood / willow), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Black cottonwood	tree	100	96	90	92	10	--	--	--
Pacific willow	tree	20	--	10	65	8	--	--	--
For all trees[1]	--	--	--	--	89	10	151	16.98	288
Creek dogwood[3]	shrub	--	--	--	--	--	--	--	--
Blue bindweed[3]	shrub	--	--	--	--	--	--	--	--
Thimbleberry[3]	shrub	--	--	--	--	--	--	--	--
Himalayan berry[3]	shrub	--	--	--	--	--	--	--	--
Evergreen blackberry[3]	shrub	--	--	--	--	--	--	--	--
Mouse-ear chickweed	forb	5	0.05	--	--	--	--	--	--
Stinging nettle	forb	40	0.3	--	--	--	--	--	--
Creeping Charlie	forb	80	0.4	--	--	--	--	--	--
Equisetum spp.	forb	25	0.1	--	--	--	--	--	--
Mosses	forb	25	0.5	--	--	--	--	--	--
Moneywort	forb	50	0.2	--	--	--	--	--	--
Ranunculus spp.	forb	5	0.05	--	--	--	--	--	--
Pacific water-parsley	forb	100	1	--	--	--	--	--	--
Bull thistle[3]	forb	--	--	--	--	--	--	--	--
Canadian thistle[3]	forb	--	--	--	--	--	--	--	--
American winter cress[3]	forb	--	--	--	--	--	--	--	--
Wild succory[3]	forb	--	--	--	--	--	--	--	--
Miner's lettuce[3]	forb	--	--	--	--	--	--	--	--
Candy flower[3]	forb	--	--	--	--	--	--	--	--
Orange balsam[3]	forb	--	--	--	--	--	--	--	--
Western bracken fern[3]	forb	--	--	--	--	--	--	--	--
Small-flowered forget-me-not[3]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	45	0.35	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 8, segment 2

Habitat: Tidal marsh

Location: Washington shore; RM 23; W. ½ S. 4, T. 9 N., R. 8 W.; Gray's Bay, east shore. Bounded on eastern (upland) side by a narrow stand of red alder adjacent to a gravel road. The lower edge of the marsh was a mud flat.

Size of area: The marsh at Gray's Bay is extensive, covering approximately 2,000 acres. The sampling area was a portion of the marsh 400 yards long by 130-150 yards wide.

Slope: 1-2 percent

Aspect: W., N.W. (280°)

Sampling methods: Sampling was done within 1 x 1 m plots spaced at 10 m intervals along four parallel transects located 100 yards apart. Transects began at the edge of the upland vegetation and ran parallel to the elevational gradient to the lower edge of the marsh vegetation.

Vegetation: Species of plants identified in the sampling area are listed in Table 32. Distribution and coverage of dominant species found in the sampling area are shown in Figure 6..

The distribution patterns of several species along transects changed as the transects' proximity to the mouth of the Gray's River increased. The upper sections of the two transects closest to the river pass through a sparsely vegetated sandy area dominated by two species of rush with clumped growth form, toad rush and spreading rush. The two transects farthest from the Gray's River begin in or contain a band dominated by birdsfoot-trefoil. The transect farthest from Gray's River starts in a patch of marsh horsetail. Lyngby's sedge dominates the next band of vegetation in all four transects. This band extends only to about 60 m on the north end of the sampling area, wheras it reaches a maximum distance of one hundred meters on the south end. There is a similar increase in the width of the zone dominated by softstem bulrush in the north end to that in the south end. Corresponding to these increases, the area dominated by beaked spike-rush decreases from north to south.

The sandy area dominated by toad rush (10%)* and spreading rush (28%) was the only example of this vegetation type found in the sampling areas. As the low cover values indicate, toad rush and spreading rush grew in well-spaced clumps that left much of the area exposed. Seedlings of American waterplantain (<1%) and wapato (<1%) grew scattered throughout these open areas. Simplestem bur-reed was the only other species that seemed to be characteristic of this vegetation type. It had low density and cover values but was observed growing in several places in the sampling area. The only other place it was recorded was in tidal channels along with waterplantain and wapato. There was also an isolated patch of three-square bulrush growing in this section. Incidental to these species, several species associated with Lyngby's sedge were also recorded. These were pointed rush (<1%), yellow

*Denotes percent cover unless otherwise specified.

monkey-flower (<1%), Watson's willow-weed (<1%), Douglas' aster (<1%), Hall's aster (<1%) and Lyngby's sedge (1%). Birdsfoot-trefoil and common rush were also noted.

To the south the upper sections of the transects contain a band of vegetation dominated by birdsfoot-trefoil (48%) that varies in width from about 10-20 m. The continuous lush vegetative cover eliminated understory plants other than deer-cabbage (3%). Lyngby's sedge (37%) codominated this vegetation zone and many species associated with it were recorded with moderate frequency and low cover values. Among these were: Douglas' aster (1%), yellow monkey-flower (<1%), western water-hemlock (<1%), Pacific water-parsley (<1%), Pacific silverweed (1%) and springbank clover (<1%). Bergamot mint, sneezeweed and a patch of beaked spike-rush were also present. Birdsfoot-trefoil, an introduced plant of European origin, may have had better success colonizing this area because of degradation suffered by the native plants from intertidal grazing. Because of the similarity of species composition it is hypothesized that the birdsfoot-trefoil dominated area is a degraded example of the mature Lyngby's sedge vegetation type.

The transect on the southern end of the sample area contains a patch of marsh horsetail approximately 10 m wide. Because of the non-foliar growth form of the species here, the cover value was very low. It was adjusted up on the basis of two thirds of the plant growing underground and an estimation of how "full" the space was. On this basis a value of 40 percent was given. Birdsfoot-trefoil (20%) had invaded the patch. Lyngby's sedge (5%) and monkey-flower (<1%) were the only other species recorded.

The three vegetation types described thus far, grade into a band dominated by Lyngby's sedge (65%) which varies from 30-80 m in width. This vegetation type covers 60 percent of the area sampled, about 14 percent of which is composed of tidal channels. Tidal channels are 30-40 centimeters deep. Lyngby's sedge is rarely found in the channels, instead relatively large, up to nine decimeters, individuals of American waterplantain and wapato were growing in them. Curled pondweed, March clubmoss and simplestem bur-reed were the submerged plants of the tide channels. The percent foliar cover of Lyngby's sedge above the channels varied from 50 to over 80 percent. The greatest number of species were recorded at the upper end of the zone: among those noted were Hall's aster (1%), Douglas' aster (5%), yellow monkey-flower (1%), western water-hemlock (1%), Pacific water-parsley (1%), pointed rush (2%), tufted hairgrass (1%), Pacific silverweed (5%) and Watson's willow-weed (<1%). Unidentified #4 and thread rush occurred in localized patches. White bog-orchid, deer-cabbage, springbank clover, fowl mannagrass, old-witch grass, small-flowered forget-me-not and common rush were present, though much less frequent than the previously listed species. The lower end of the zone graded into vegetation dominated primarily by beaked spike-rush on the north and softstem bulrush on the south. Beaked spike-rush occurred in some plots within the Lyngby's sedge zone in which the sedge had a cover value of about 50 percent.

The zone dominated by rings of softstem bulrush and/or more solid patches of beaked spike-rush comprised 36 percent of the area sampled. The zone itself extended much further, but was only accessible on foot at very low tides. About nine percent of the sample area was clearly dominated by

beaked spike-rush (35%). A few individuals of species common to the sedge zone have invaded this stand: Lyngby's sedge (2%), pointed rush (<1%), yellow monkey-flower (<1%) and western water-hemlock (<1%). Flowering quillwort (1%) was the most abundant understory species in both the beaked spike-rush dominated plots and those dominated by softstem bulrush. Mature plants of western waterplantain and wapato grew scattered throughout the zone. Submerged plants such as curled pondweed (3%), and Canadian waterweed occurred in association with softstem bulrush (10%) where it was growing in deep water. Softstem bulrush dominated most of the zone due to its height, which averaged nineteen decimeters. It also appears to dominate the area in aerial photographs, where its circular distribution is readily observable. This growth pattern, the absence of foliar parts and the self-spacing of the species resulted in the deceptively low cover values.

Table 32. Plants identified in sampling area 8 (tidal marsh), segment 2.

American waterplantain
Hall's aster
Douglas' aster
Nodding beggars-tick
Lyngby's sedge
Western water-hemlock
Tufted hairgrass
Beaked spike-rush
Canadian waterweed
Watson's willow-weed
Marsh horsetail
Fowl mannagrass
White bog-orchid
Sneezeweed
Toad rush
Common rush
Thread rush
Pointed rush
Spreading rush
Cutgrass
Flowering quillwort
Mudwort
Birdsfoot-trefoil
March clubmoss
Bergamot mint
Yellow monkey-flower
Small-flowered forget-me-not
Deer-cabbage
Pacific water-parsley
Old-witch grass
Waterpepper
Curled pondweed
Pacific silverweed
Self-heal
Wapato
Hardstem bulrush
Three-square bulrush
Small-flowered bulrush
Softstem bulrush
Simplestem bur-reed
Springbank clover

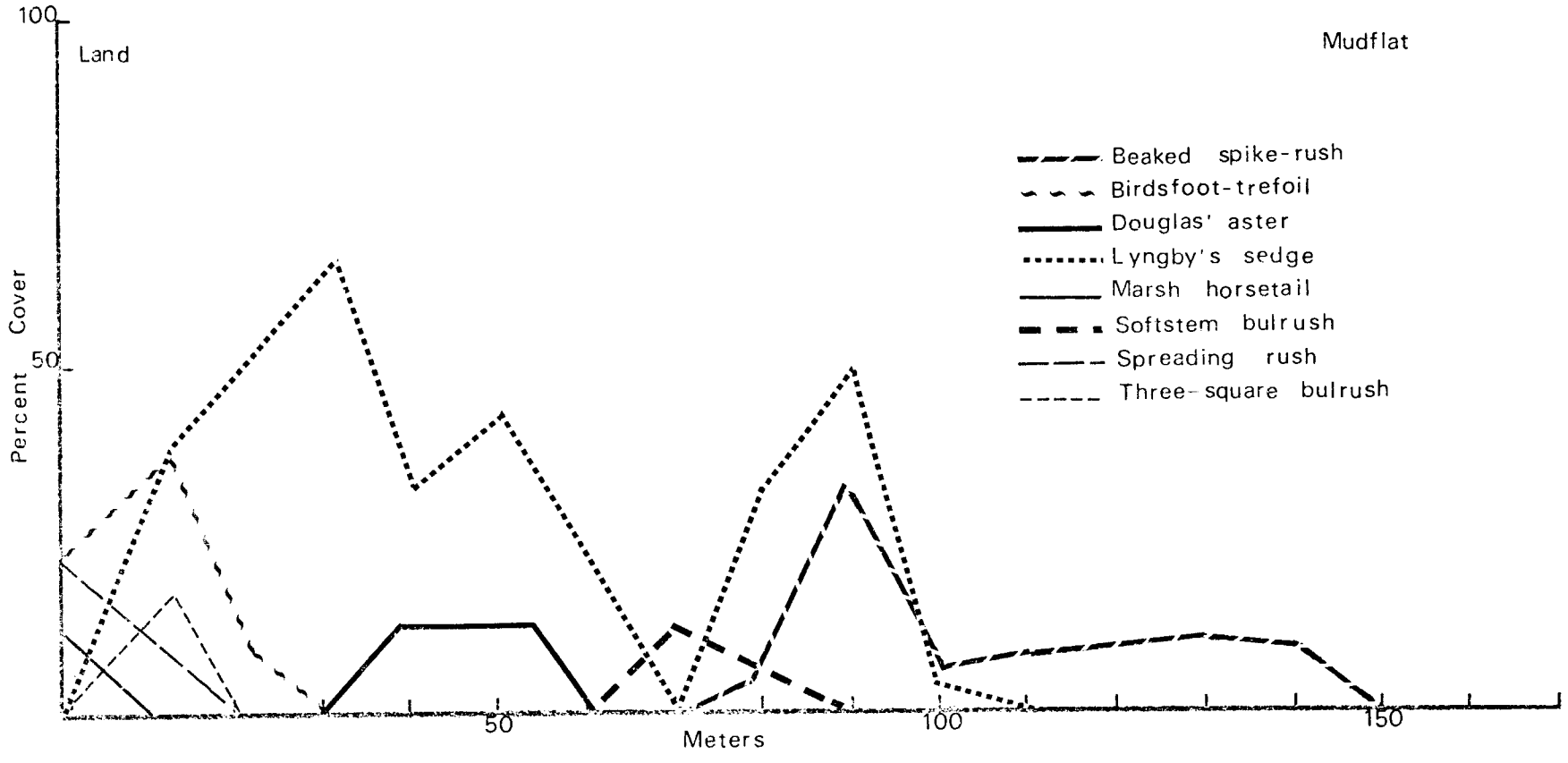

Figure 6. Distribution and cover of dominant species of plants found in sampling area 8, segment 2.

Sampling area: 9, segment 2

Habitat: Sitka spruce (Sitka spruce / salmonberry--snowberry / skunk cabbage)

Location: Washington shore; RM 37; N.W. ¼ S. 35, T. 9 N., R. 6 W. The stand is on a peninsula with the Elokomin Slough on the north, west, and south. Highway 12 borders the stand on the east.

Size of area: Approximately 600 yards by 200 yards

Slope: None

Aspect: None

Elevation: Near sea level

Soil: Clay, mixed with high amounts of organic matter. Tidal channels and bogs are common; the soil throughout the stand is water saturated. High tides inundate most of the soil surface.

Vegetation: Sitka spruce and black cottonwood comprise the largest portion of the forest canopy; mean heights of 76 and 81 feet respectively (Table 33). Western red cedar, Oregon ash, red alder, vine maple, Pacific and Hooker's willow, complete the tree layer of the community.

Salmonberry, snowberry, and vine maple dominate the dense shrub understory (Table 33). Other shrubs common to the stand are salal, twinberry, creek dogwood and blue bindweed.

Mosses cover the dead trees and shrubs. Skunk cabbage, with leaves often shrub size, cover a large area. Orange balsam, small-flowered forget-me-not, and poison hemlock are common in areas of standing water.

Of the associated species, (Table 33), swamp bedstraw, sword fern, and slough sedge were most common.

Ground coverage: Live vegetation 12 percent, litter 34 percent, bare ground 14 percent, and water 33 percent

Table 33. Vegetative composition of intensive sampling area 9 (Sitka spruce), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Sitka spruce	tree	90	42	46	76	14	--	--	--
Black cottonwood	tree	50	--	23	81	14	--	--	--
Western red cedar	tree	30	13	7	47	12	--	--	--
Oregon ash	tree	10	21	2	30	3	--	--	--
Red alder	tree	30	--	12	51	7	--	--	--
Vine maple	tree	10	50	2	22	3	--	--	--
Pacific willow	tree	30	--	7	47	5	--	--	--
Hooker's willow	tree	10	--	2	35	6	--	--	--
For all trees[1]	--	--	--	--	66	11	95	21.43	459
Salal	shrub	20	12	--	4	--	120	--	--
Wild trailing blackberry	shrub	10	2	--	4	--	30	--	--
Salmonberry	shrub	60	7	--	5	--	140	--	--
Wood rose	shrub	10	--	--	4	--	10	--	--
Creek dogwood	shrub	20	8	--	7	--	80	--	--
Blue bindweed	shrub	10	2	--	5	--	30	--	--
Snowberry	shrub	60	7	--	3	--	130	--	--
Vine maple	shrub	40	46	--	7	--	100	--	--
Pacific serviceberry	shrub	10	--	--	3	--	30	--	--
Ninebark	shrub	10	--	--	5	--	10	--	--
Coast red elder	shrub	10	--	--	5	--	10	--	--
Twinberry	shrub	10	--	--	4	--	120	--	--
Thimbleberry[3]	shrub	--	--	--	--	--	--	--	--
Skunk cabbage	forb	35	1.85	--	--	--	--	--	--
Unidentified #2	forb	20	0.15	--	--	--	--	--	--
Small-flowered forget-me-not	forb	15	0.25	--	--	--	--	--	--
Orange balsam	forb	25	0.1	--	--	--	--	--	--
Maidenhair fern	forb	5	0.05	--	--	--	--	--	--
Poison hemlock	forb	5	0.05	--	--	--	--	--	--
Mosses	forb	20	3.35	--	--	--	--	--	--
Western bracken fern	forb	5	0.05	--	--	--	--	--	--
Sword fern[3]	forb	--	--	--	--	--	--	--	--
Small cleavers[3]	forb	--	--	--	--	--	--	--	--

Table 33. Continued.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Laythrus spp.[3]	forb	--	--	--	--	--	--	--	--
Creeping Charlie[3]	forb	--	--	--	--	--	--	--	--
Western buttercup[3]	forb	--	--	--	--	--	--	--	--
Slough sedge[3]	forb	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 15, segment 2

Habitat: Tidal marsh (Softstem bulrush)

Location: Island; RM 30; W. ½ S. 24, T. 9 N., R. 7 W.; Quinns Island. This marsh is on a low sandy flat surrounded on three sides by steep banked, (30 or more centimeters high) sedge marsh.

Size of area: The stand is approximately 200 x 300 yards in size.

Slope: Less than 5 percent

Aspect: W., N.W. (285°)

Sampling methods: The marsh was sampled as a homogenous stand. Sampling plots 1 x 1 m in size were located at 10 m intervals along a transect through the center of the marsh.

Vegetation: Species of plants identified in the sampling area are listed in Table 34. Distribution and coverage of dominant species found in the sampling area are shown in Figure 7.

Vegetation within the sampling area consisted of patches dominated by softstem bulrush or beaked spike-rush. Spike-rush dominated 12 percent of the plots and 25 percent contained both spike-rush and softstem bulrush. Bergia (<1%)* and mudwort (<1%) were widespread understory species. Immature plants of wapato (<1%) and American water-plantain (<1%) were growing in the shallow tidal channels. Lyngby's sedge, yellow monkey-flower, and waterpepper were the only species common to the mature sedge marsh that were found in a few places in the sample area.

The mature sedge marsh contained scattered patches of lesser cat-tail and reed canarygrass. The visual dominants were tufted hairgrass and yellow monkey-flower, neither of which were very abundant.

*Denotes percent cover unless otherwise specified.

Table 34. Plants identified in sampling area 15 (tidal marsh), segment 2.

American waterplantain
Bergia
Lyngby's sedge
Tufted hairgrass
Beaked spike-rush
Mudwort
Yellow monkey-flower
Reed canarygrass
Waterpepper
Wapato
Softstem bulrush

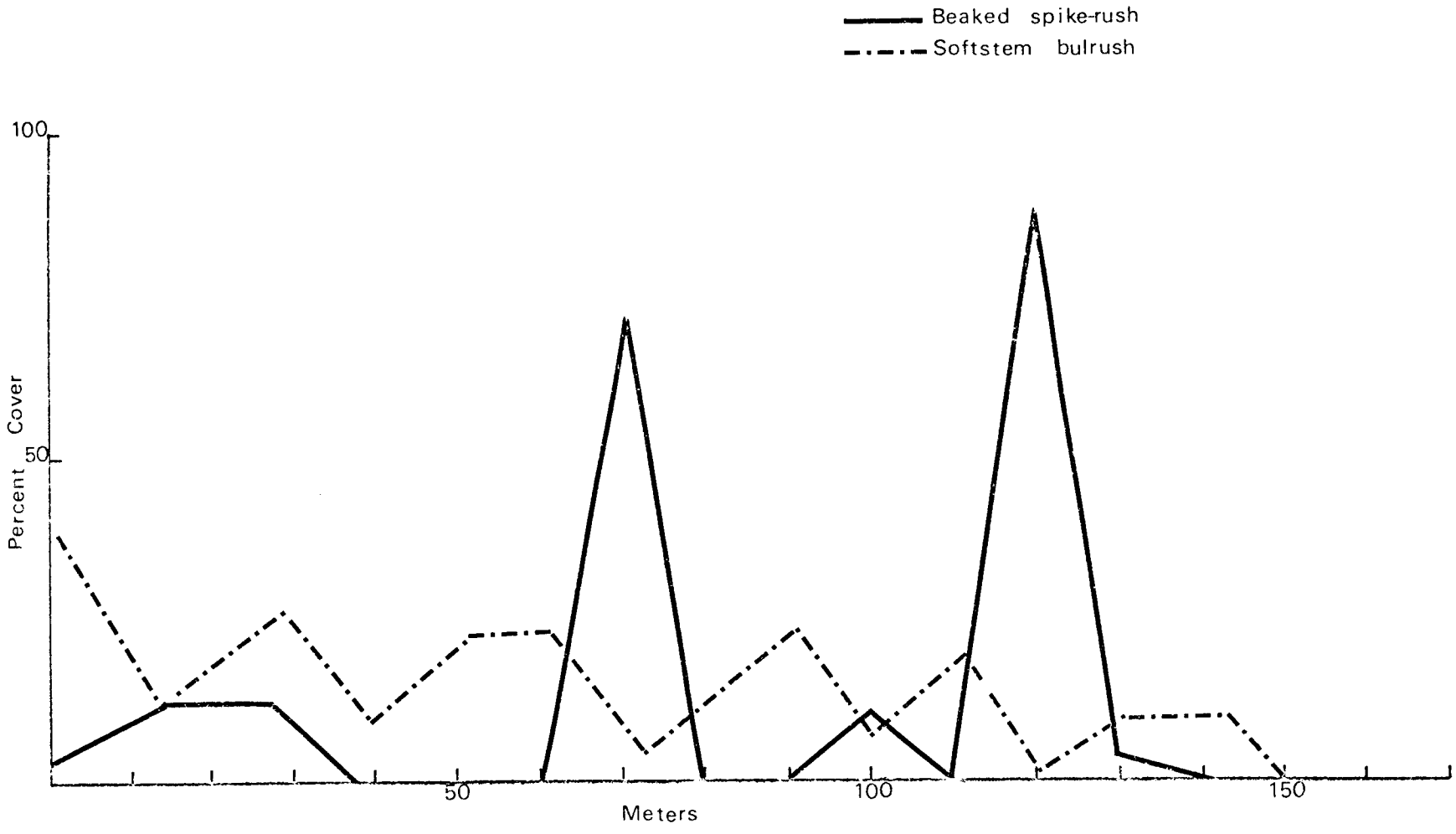

Figure 7. Distribution and coverage of dominant species of plants found in sampling area 15, segment 2.

Sampling area: 16, segment 2

Habitat: Tidal marsh

Location: Island; RM 32; N.W. ¼ S. 19, T. 9 N., R. 6 W.; Welch Island. The marsh is bordered on the south and east by willows and on the other sides by the Columbia River.

Size of area: The stand sampled is approximately 250 by 100 yards and makes up about half the total area of marsh on the island.

Slope: 1-2 percent

Aspect: S.W. (225°)

Sampling methods: The area was sampled as a homogenous stand using 1 x 1 m plots at 10 m intervals along a transect through the stand.

Vegetation: Species of plants identified in the stand are listed in Table 35. Distribution and coverage of dominant species found in the sampling area are shown in Figure 8.

Welch Island is an island of intermediate age. The north end where sand has most recently accreted is covered with beaked spike-rush, which also grows in the outlets of the tidal channels. This changes rapidly into a marsh dominated by Lyngby's sedge. Shallow roots of the sedge fill the substrate completely and sheds an abundance of leaf material which decomposes rapidly. These factors and propensity of Lyngby's sedge to trapping debris have resulted in increased elevation. The surface of the island where the sedge marsh dominates is approximately 30 centimeters above the tideflat. Most high tides inundate the island and the marsh is criss-crossed by a network of moderately deep drainage channels. The island developed on sand but the lower sediments of the soil profile are stratified silts and peats with some clay and an upper organic layer of a couple centimeters.

A large number of species have colonized the island. Many of these are characteristic species of mature sedge marsh. But none of the species other than Lyngby's sedge have become well established. The average cover value for Lyngby's sedge, excluding values for tide channels, was 70 percent. Near the willows, Lyngby's sedge drops out almost completely. Pointed rush (5%)*, which maintained a low percent cover value with a very high frequency, increased to a cover value of 10 percent. It is a very conspicuous species due to its height and was considered a visual dominant along with the following marsh plants: Pacific water-parsley (<1%), western water-hemlock (<1%), Hall's aster (<1%), yellow monkey-flower (1%). Marsh horsetail (<1%), deer cabbage (2%) and waterpepper (1%) were species with high frequencies but which were inconspicuous. Tufted hairgrass, creeping bentgrass and Watson's willow-weed were high marsh plants infrequently encountered. American water-plantain (2%), beaked spike-rush (5%), skunk cabbage (2%) and wapato occurred most frequently in or on the banks of tide channels. A few of the species listed for this area such as white bog-orchid were found within the willows but were components of the marsh vegetation in other areas sampled.

*Denotes percent cover unless otherwise specified.

Table 35. Plants identified in sampling area 16 (tidal marsh), segment 2.

Creeping bentgrass
American waterplantain
Hall's aster
Nodding beggars-tick
Lyngby's sedge
Western water-hemlock
Tufted hairgrass
Beaked spike-rush
Watson's willow-weed
Giant helleborine
Marsh horsetail
Pacific bedstraw
Fowl mannagrass
White bog-orchid
Orange balsam
Pointed rush
Cutgrass
Skunk cabbage
Field mint
Yellow monkey-flower
Small-flowered forget-me-not
Deer-cabbage
Pacific water-parsley
Waterpepper
Wapato

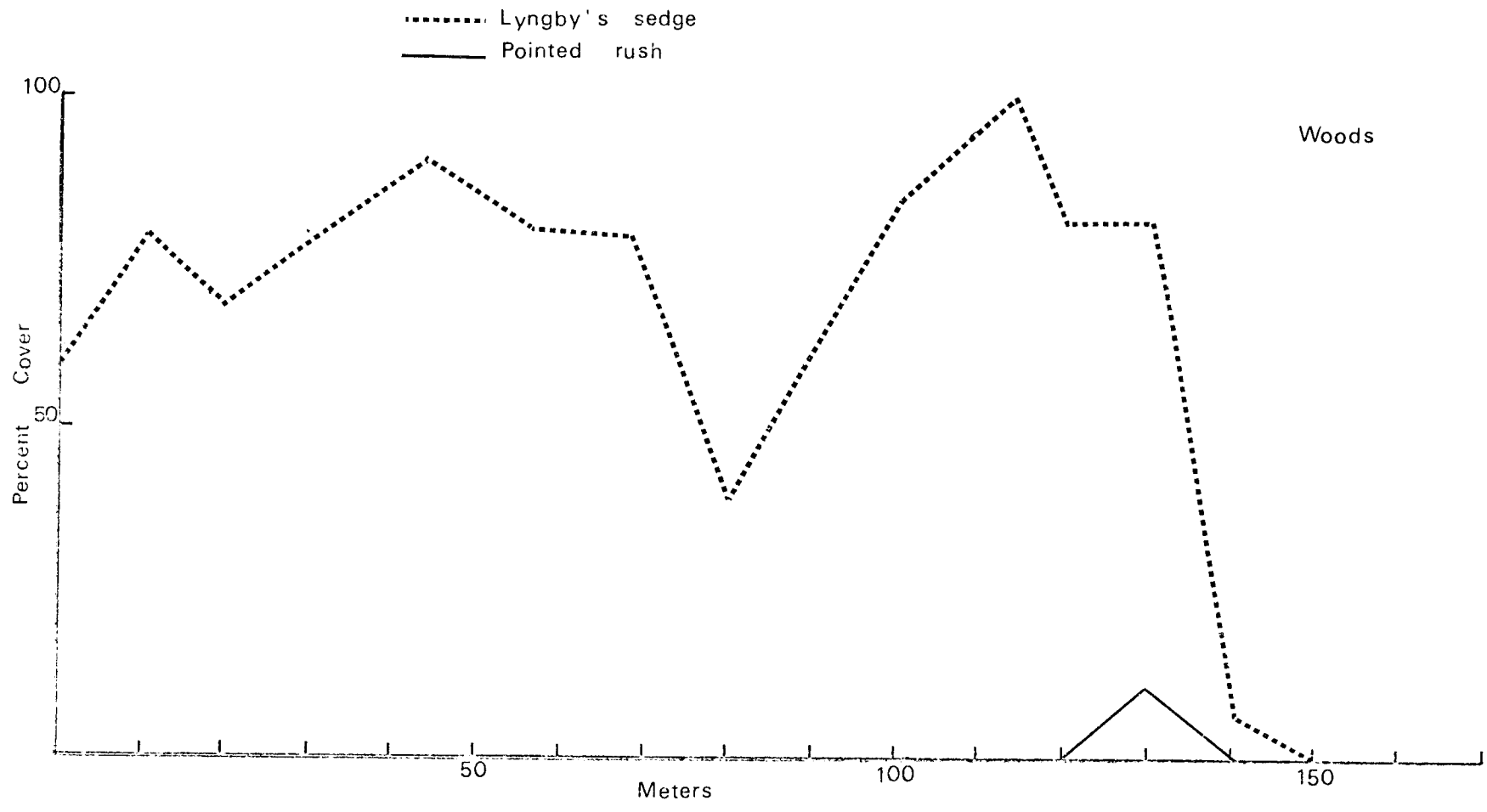

Figure 8. Distribution and coverage of dominant species of plants found in sampling area 16, segment 2.

Sample area: 17, segment 2

Habitat: Tidal shrub willow (Hooker's willow / bentgrass)

Location: Island; RM 32; N. ½ S. 19, T. 9 N., R. 6 W.; Welch Island; Lewis and Clark NWR. The northern edge of the stand is a tidal channel. Clifton Channel forms the western edge. The eastern and southern portions of the stand is bordered by open areas of Lyngby's sedge, reed canarygrass, and scattered Hooker's willow.

Size of area: Approximately 600 yards by 50 yards

Slope: None

Aspect: None

Elevation: Near sea level

Soil: Sandy loam, subject to daily flooding from high tides

Vegetation: Trees are lacking in the sample area, the canopy is entirely shrubs. Hooker's willow had the highest density value (360 plants/acre) and averaged approximately 18 feet in height (Table 36). Other shrubs common to the area, listed in order of decreasing density values, are creek dogwood, Pacific willow, Columbia River willow, and twinberry.

The herbaceous understory is composed mainly of bentgrass, skunk cabbage, small-flowered forget-me-not, and Douglas' aster (Table 36).

Several species occur in the sample area that were not present in the study plots. Reed canarygrass, thread rush, yellow flag, and purple beach pea were among the more common associated species (Table 36).

Tidal channels are present in the entire area.

Ground coverage: Live vegetation 13 percent, litter 18 percent, and bare ground 70 percent

Table 36. Vegetative composition of intensive sampling area 17 (tidal shrub willow), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[1] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[1] AREA (ft)
Creek dogwood	shrub	60	20	--	6	--	230	--	--
Hooker's willow	shrub	90	67	--	18	--	360	--	--
Pacific willow	shrub	30	26	--	12	--	120	--	--
Twinberry	shrub	10	5	--	12	--	30	--	--
Columbia River willow	shrub	20	16	--	15	--	70	--	--
Equisetum spp.	forb	50	0.3	--	--	--	--	--	--
Skunk cabbage	forb	65	0.95	--	--	--	--	--	--
California false hellebore	forb	10	0.05	--	--	--	--	--	--
Orange balsam	forb	80	0.55	--	--	--	--	--	--
Small-flowered forget-me-not	forb	80	0.9	--	--	--	--	--	--
Cleavers	forb	5	0.05	--	--	--	--	--	--
Pacific silverweed	forb	10	0.05	--	--	--	--	--	--
Great northern aster	forb	15	0.05	--	--	--	--	--	--
Trifolium spp.[2]	forb	--	--	--	--	--	--	--	--
Yellow marsh marigold[2]	forb	--	--	--	--	--	--	--	--
Ranunculas spp.[2]	forb	--	--	--	--	--	--	--	--
Purple beach pea[2]	forb	--	--	--	--	--	--	--	--
Giant vetch[2]	forb	--	--	--	--	--	--	--	--
Rumex spp.[2]	forb	--	--	--	--	--	--	--	--
Thread rush[2]	forb	--	--	--	--	--	--	--	--
Yellow flag[2]	forb	--	--	--	--	--	--	--	--
Carex spp.[2]	forb	--	--	--	--	--	--	--	--
American winter cress[2]	forb	--	--	--	--	--	--	--	--
Western bracken fern[2]	forb	--	--	--	--	--	--	--	--
Lyngby's sedge[2]	forb	--	--	--	--	--	--	--	--
Bentgrass	grass	65	1.75	--	--	--	--	--	--
Early hairgrass[2]	grass	--	--	--	--	--	--	--	--
Reed canarygrass[2]	grass	--	--	--	--	--	--	--	--

[1]Basal area for forbs, canopy cover for trees and shrubs.
[2]Species was present in stand but did not occur in sample plots.

Sampling area: 18, segment 2

Habitat: Sitka spruce (Sitka spruce / trailing blackberry--creek dogwood--snowberry / slough sedge)

Location: Island; RM 36; S.W. ¼ S. 27, T. 9 N., R. 6 W.; North Hunting Island. The stand is bordered on all sides by open water.

Size of area: Approximately 350 yards long and 50-100 yards wide

Slope: None

Aspect: None

Elevation: Near sea level

Soil: Sandy clay; litter approximately 2 inches deep

Vegetation: The canopy is mature Sitka spruce with an average height of 114 feet and dbh of 32 inches (Table 37). Red alder, Columbia River willow, Oregon ash, swamp crabapple, creek dogwood, and Pacific willow complete the canopy, and provide a layering effect in the tree coverage. Because of the numerous snags and fallen trees in the area and the very dense shrub understory, walking in the area is nearly impossible.

Snowberry, trailing blackberry, and creek dogwood co-dominate the shrub understory with an average density of approximately 480 plants/acre for each species. The average heights are 5, 4, and 10 feet respectively. Salmonberry and wild wood rose are also common (Table 37).

Slough sedge is the most common forb with a coverage value of 1.8 percent. Mosses cover large portions of decaying trees and litter and is prevalent throughout the stand. Western maidenhair fern, western bracken fern, and orange balsam also occurred in sample plots.

Sword fern, skunk cabbage, swamp bedstraw and equisetum were noted within the stand but did not occur in sample plots (Table 37).

Ground coverage: Live vegetation 10 percent, litter 64 percent, bare ground 27 percent

Table 37. Vegetative composition of intensive sampling area 18 (Sitka spruce), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Sitka spruce	tree	90	55	62	114	32	--	--	--
Pacific willow	tree	10	--	2	52	6	--	--	--
Western crabapple	tree	10	--	2	32	3	--	--	--
Red alder	tree	80	21	22	50	9	--	--	--
Columbia River willow	tree	10	--	5	24	3	--	--	--
Creek dogwood	tree	10	10	2	20	3	--	--	--
Oregon ash	tree	10	--	2	60	6	--	--	--
For all trees[1]	--	--	--	--	77	18	78	23.56	557
Snowberry	shrub	80	25	--	5	--	480	--	--
Thimbleberry	shrub	10	--	--	6	--	40	--	--
Ninebark	shrub	10	1	--	5	--	10	--	--
Salmonberry	shrub	50	11	--	7	--	140	--	--
Creek dogwood	shrub	90	46	--	10	--	450	--	--
Wild trailing blackberry	shrub	90	15	--	4	--	510	--	--
Twinberry	shrub	10	2	--	8	--	10	--	--
Wood rose	shrub	50	22	--	5	--	200	--	--
Western crabapple	shrub	10	--	--	3	--	10	--	--
Columbia River willow	shrub	10	--	--	14	--	10	--	--
Fern spp.	forb	10	0.05	--	--	--	--	--	--
Slough sedge	forb	80	1.8	--	--	--	--	--	--
Mosses	forb	45	3.65	--	--	--	--	--	--
Maidenhair fern	forb	5	0.05	--	--	--	--	--	--
Orange balsam	forb	15	0.05	--	--	--	--	--	--
Cultivated ivy	forb	5	0.05	--	--	--	--	--	--
Western bracken fern	forb	5	0.05	--	--	--	--	--	--
Sword fern[3]	forb	--	--	--	--	--	--	--	--
Skunk cabbage[3]	forb	--	--	--	--	--	--	--	--
Small cleavers[3]	forb	--	--	--	--	--	--	--	--
Equisetum spp.[3]	forb	--	--	--	--	--	--	--	--
Cleavers[3]	forb	--	--	--	--	--	--	--	--
Small-flowered forget-me-not[3]	forb	--	--	--	--	--	--	--	--
Vicia spp.[3]	forb	--	--	--	--	--	--	--	--

Table 37. Continued.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Kentucky bluegrass[3]	grass	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 19, segment 2

Habitat: Cottonwood (black cottonwood / stinging nettle)

Location: Island; RM 75; S.W. ¼ S. 7, T. 6 N., R. 1 W.; Sandy Island.

Size of area: Approximately 750 yards by 100 yards

Slope: None

Aspect: None

Elevation: 10-15 feet

Soil: Sandy loam covered with up to 1 inch of organic matter

Vegetation: Mature black cottonwood makes up the canopy of the stand. The cottonwoods, which average 106 feet tall, make up 97 percent of the canopy. The only other tree recorded was Hooker's willow (Table 38).

Shrubs are not prominent in the stand, although trailing blackberry, creek dogwood, coast red elder, and blue bindweed are distributed sparingly throughout the area.

Stinging nettle, averaging 7 feet tall, visually dominates the herbaceous understory. Moss has the greatest basal area coverage, followed by stinging nettle, winter cress, and Pacific water-parsley. Reed canarygrass occurs sparingly in the area.

Table 38 lists several species that were observed within the stand but did not occur in sample plots.

Ground coverage: Litter 90 percent, live vegetation 10 percent

Table 38. Vegetative composition of intensive sampling area 19 (cottonwood), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Black cottonwood	tree	100	97	95	106	14	--	--	--
Hooker's willow	tree	20	--	5	48	6	--	--	--
For all trees[1]	--	--	--	--	102	14	77	23.83	568
Creek dogwood	shrub	20	1	--	2	--	30	--	--
Wild trailing blackberry	shrub	20	7	--	4	--	170	--	--
Blue bindweed	shrub	20	--	--	1	--	20	--	--
Coast red elder	shrub	20	--	--	3	--	30	--	--
Black cottonwood	shrub	10	--	--	3	--	10	--	--
Stinging nettle	forb	70	0.6	--	--	--	--	--	--
Mosses	forb	65	8.95	--	--	--	--	--	--
Winter cress	forb	20	0.15	--	--	--	--	--	--
Pacific water-parsley	forb	10	0.1	--	--	--	--	--	--
Creeping Charlie[3]	forb	--	--	--	--	--	--	--	--
Cleavers[3]	forb	--	--	--	--	--	--	--	--
American speedwell[3]	forb	--	--	--	--	--	--	--	--
Canadian thistle[3]	forb	--	--	--	--	--	--	--	--
Equisetum spp.[3]	forb	--	--	--	--	--	--	--	--
Miner's lettuce[3]	forb	--	--	--	--	--	--	--	--
Western bracken fern[3]	forb	--	--	--	--	--	--	--	--
Small-flowered forget-me-not[3]	forb	--	--	--	--	--	--	--	--
Foxglove[3]	forb	--	--	--	--	--	--	--	--
Red dock[3]	forb	--	--	--	--	--	--	--	--
Mouse-eared chick-weed[3]	forb	--	--	--	--	--	--	--	--
Orange balsam[3]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	15	0.1	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 20, segment 2

Habitat: Cottonwood / willow (black cottonwood--Pacific willow / reed canarygrass)

Location: Island; RM 75; S.W. ¼ S. 7, T. 6 N., R. 1 W.; Sandy Island. The stand is surrounded by reed canarygrass, meadow, and the river shore.

Size of area: Approximately 500 yards by 60 yards

Slope: None

Aspect: None

Elevation: 10-12 feet

Soil: Sand; the topsoil contains a high percentage of peat.

Vegetation: Black cottonwood, Pacific willow, and Oregon ash form the forest canopy. Cottonwood and willow are the dominates with 48 and 37 percent cover, respectively. The sample area has a tree density of 54 trees/acre and a mean height of 79 feet (Table 39).

Pacific willow is also common in the understory and was the only shrub to appear in sample plots. Himalayan berry, trailing blackberry, creek dogwood, blue bindweed, and coast red elder are spread throughout the stand in moderate numbers, however.

Herbaceous cover consists mainly of reed canarygrass, which was approximately seven feet in height where sampling was done. Dried grass from previous years provides 1-2 inches of litter in many areas. Forbs are common throughout the stand; stinging nettle and American speedwell occur most frequently. Forbs observed in the stand, but not in sample plots are: creeping Charlie, blunt-leaved yellow cress, bull thistle, sword and western bracken ferns.

Vegetative cover: Live vegetation 1.45 percent, litter 88 percent, bare ground 9.75 percent

Table 39. Vegetative composition of intensive sampling area 20 (cottonwood / willow), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Oregon ash	tree	20	--	5	74	8	--	--	--
Black cottonwood	tree	80	41	58	90	10	--	--	--
Pacific willow	tree	60	28	37	64	13	--	--	--
For all trees[1]	--	--	--	--	79	11	54	28.46	810
Pacific willow	shrub	30	23	--	14	--	30	--	--
Himalayan berry[3]	shrub	--	--	--	--	--	--	--	--
Wild trailing blackberry[3]	shrub	--	--	--	--	--	--	--	--
Creek dogwood[3]	shrub	--	--	--	--	--	--	--	--
Blue bindweed[3]	shrub	--	--	--	--	--	--	--	--
Coast red elder[3]	shrub	--	--	--	--	--	--	--	--
Cleavers	forb	5	0.05	--	--	--	--	--	--
American speedwell	forb	10	0.05	--	--	--	--	--	--
Miner's lettuce	forb	5	0.05	--	--	--	--	--	--
Mosses	forb	5	0.05	--	--	--	--	--	--
Stinging nettle	forb	10	0.05	--	--	--	--	--	--
Equisetum spp.[3]	forb	--	--	--	--	--	--	--	--
Creeping Charlie[3]	forb	--	--	--	--	--	--	--	--
Winter cress[3]	forb	--	--	--	--	--	--	--	--
Bull thistle[3]	forb	--	--	--	--	--	--	--	--
Sword fern[3]	forb	--	--	--	--	--	--	--	--
Western bracken fern[3]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	85	1.35	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 22, segment 2

Habitat: Reed canarygrass

Location: Island; RM 75; N.W. ¼ S. 18, T. 6 N., R. 1 W.; Sandy Island. The stand occupies a plain between a slough channel on the east and a black cottonwood community on the west side of the island.

Size of area: Approximately 170 yards by 50 yards and tapering to 25 yards at the N.W. and S.E. ends of the stand.

Slope: None

Aspect: None

Elevation: 5-10 feet

Soil: Silty sand; subject to frequent flooding.

Vegetation: An essentially "pure" community of reed canarygrass (Table 40). Other grasses or forbs occurred in the sample plots. Blunt-leaved yellow cress, stinging nettle, equisetum, orange balsam, American speedwell, monkey flower, and shepard's purse were noted growing sparingly near the edges of the sample area.

Ground coverage: Live vegetation 3 percent, litter 56 percent, and bare ground 41 percent

Table 40. Vegetative composition of intensive sampling area 22 (reed canarygrass), segment 2.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[1] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[1] AREA (ft)
Shepard's purse[2]	forb	--	--	--	--	--	--	--	--
Monkey flower[2]	forb	--	--	--	--	--	--	--	--
American speedwell[2]	forb	--	--	--	--	--	--	--	--
Orange balsam[2]	forb	--	--	--	--	--	--	--	--
Equisetum spp.[2]	forb	--	--	--	--	--	--	--	--
Stinging nettle[2]	forb	--	--	--	--	--	--	--	--
Winter cress[2]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	100	3.05	--	--	--	--	--	--

[1]Basal area for forbs, canopy cover for trees and shrubs.
[2]Species was present in stand but did not occur in sample plots.

Sampling area: 1, segment 3

Habitat: Cottonwood, grazed (black cottonwood / trailing blackberry / stinging nettle)

Location: Oregon shore; RM 89; W. ½ S. 22, T. 4 N., R. 1 W.; Sauvie Island WMA. The eastern edge of the stand is formed by the river shore; the southern edge by grass pasture; and the western and northern edges by mixtures of ash, willow, and cottonwood.

Size of area: Approximately 600 yards by 100 yards

Slope: None

Aspect: None

Elevation: 13-17 feet

Soil: Sandy loam, very deep

Vegetation: Black cottonwood completely encloses the canopy of the stand; the cover value is near 100 percent. The cottonwoods average 135 feet in height and 14 inches dbh. Oregon ash and Pacific willow occur with moderate frequency under the black cottonwood canopy. Average heights are 53 and 66 feet, respectively.

Trailing blackberry, mean height 1 foot, has the highest density and frequency values of the shrub layer species present but because of its low growth habit is not the visual dominant. Snowberry is the visually dominant shrub and approaches trailing blackberry's density (Table 41). Other shrubs present in the community include wild wood rose, coast red elder, and shrub-size black cottonwood. Creek dogwood and blue bindweed are also present but were not recorded in sample plots.

Stinging nettle, reed canarygrass, equisetum, and mosses were the major components of the herbaceous understory. Stinging nettle 2-7 feet in height was the visual dominant. Mosses are prevalent on all fallen trees, shrubs and litter.

Grazing pressure: The sampling area is grazed heavily by cattle.

Ground coverage: Live vegetation 1 percent, litter 64 percent, bare ground 35 percent

Table 41. Vegetative composition of intensive sampling area 1 (cottonwood, grazed), segment 3.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Black cottonwood	tree	100	100	72	135	14	--	--	--
Oregon ash	tree	30	22	7	53	7	--	--	--
Pacific willow	tree	40	10	20	66	10	--	--	--
For all trees[1]	--	--	--	--	115	13	152	16.94	287
Wild trailing blackberry	shrub	90	6	--	1	--	390	--	--
Wood rose	shrub	20	1	--	3	--	30	--	--
Snowberry	shrub	40	14	--	4	--	370	--	--
Coast red elder	shrub	30	3	--	8	--	150	--	--
Black cottonwood	shrub	20	3	--	3	--	70	--	--
Blue bindweed[3]	shrub	--	--	--	--	--	--	--	--
Creek dogwood[3]	shrub	--	--	--	--	--	--	--	--
Stinging nettle	forb	75	3.75	--	--	--	--	--	--
Mosses	forb	40	2.0	--	--	--	--	--	--
Equisetum spp.	forb	5	0.25	--	--	--	--	--	--
Reed canarygrass	forb	5	0.25	--	--	--	--	--	--
Canadian thistle[3]	forb	--	--	--	--	--	--	--	--
Sword fern[3]	forb	--	--	--	--	--	--	--	--
Maidenhair fern[3]	forb	--	--	--	--	--	--	--	--
Inside-out flower[3]	forb	--	--	--	--	--	--	--	--
Cleavers[3]	forb	--	--	--	--	--	--	--	--
Winter cress[3]	forb	--	--	--	--	--	--	--	--
Giant hedge nettle[3]	forb	--	--	--	--	--	--	--	--
Woods buttercup[3]	forb	--	--	--	--	--	--	--	--
American speedwell[3]	forb	--	--	--	--	--	--	--	--
Mouse-eared chickweed[3]	forb	--	--	--	--	--	--	--	--
Impatiens spp.[3]	forb	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 2, segment 3

Habitat: Pacific willow--black cottonwood / trailing blackberry / reed canarygrass

Location: Oregon shore; RM 91; N.E. ¼ S. 34, T. 4 N., R. 1 W.; Sauvie Island WMA. The stand is bordered on the east by sandy beach, on the south and west by roads.

Size of area: Approximately 500 yards long and 100 yards wide; the north and south ends of the stand taper to approximately 65 yards wide.

Slope: None

Aspect: None

Elevation: 10-15 feet

Soil: Deep, sandy loam covered with 1-2 inches of organic matter

Vegetation: The forest canopy consists mainly of Pacific willow and black cottonwood. Pacific willow, average height 72 feet, tends to occur less frequently but has higher cover and relative density values, black cottonwood averages 110 feet in height (Table 42).

Trailing blackberry has a high density and "blackberry clumps", approximately 4 feet tall, are common. Coast red elder, Columbia River willow, Piper's willow and blue bindweed occur at low densities throughout the stand.

Reed canarygrass provides 65 percent of the herbaceous cover. The grass was about 6 feet tall where sampling was conducted in July. A thick layer of litter from previous years growth was present under the reed canarygrass.

The forbs, listed in order of decreasing cover values, encountered on sample plots were stinging nettle, Pacific bedstraw, giant hedge nettle, and equisetum. American winter cress, lady fern, orange touch-me-not, and orange balsam were noted within the stand but did not occur in plots.

Ground coverage: Live vegetation 2 percent and litter 98 percent

Table 42. Vegetative composition of intensive sampling area 2 (Pacific willow--black cottonwood / trailing blackberry / reed canarygrass), segment 3.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Pacific willow	tree	60	78	65	72	9	--	--	--
Black cottonwood	tree	90	27	35	110	13	--	--	--
Columbia River willow[3]	tree	--	--	--	--	--	--	--	--
Piper's willow[3]	tree	--	--	--	--	--	--	--	--
For all trees[1]	--	--	--	--	85	10	241	13.45	181
Wild trailing blackberry	shrub	70	30	--	4	--	180	--	--
Coast red elder	shrub	10	--	--	2	--	10	--	--
Blue bindweed[3]	shrub	--	--	--	--	--	--	--	--
Creek dogwood[3]	shrub	--	--	--	--	--	--	--	--
Stinging nettle	forb	50	0.20	--	--	--	--	--	--
Mosses	forb	20	0.25	--	--	--	--	--	--
Pacific bedstraw	forb	5	0.05	--	--	--	--	--	--
Giant hedge nettle	forb	5	0.05	--	--	--	--	--	--
Equisetum spp.	forb	10	0.05	--	--	--	--	--	--
Lady fern[3]	forb	--	--	--	--	--	--	--	--
Winter cress[3]	forb	--	--	--	--	--	--	--	--
Orange balsam[3]	forb	--	--	--	--	--	--	--	--
Spurless balsam[3]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	95	1.15	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 3, segment 3

Habitat: Ash / willow / cottonwood (Oregon ash / trailing blackberry / moneywort)

Location: Oregon shore; RM 91; N. ½ S. 34, T. 4 N., R. 1 W.; Sauvie Island WMA. The stand is bordered on the east and north by open pastureland and on the west and south by McNary Lake.

Size of area: Approximately 500 yards by 250 yards

Slope: None

Aspect: None

Elevation: 10-15 feet

Soil: Clay loam covered with ½-1 inch of litter

Vegetation: Oregon ash dominates the trees of the stand. It averaged 64 feet in height and had a frequency value of 100 percent (Table 43). Although the mean dbh is 10 inches, trees with up to 36 inch dbh were noted in the stand. Black cottonwood and Pacific willow complete the forest canopy.

The shrub understory is sparse and appears to have been reduced by grazing. Trailing blackberry has the highest density value, followed by shrub-size Oregon ash and black cottonwood respectively (Table 43). Blue bindweed, Himalayan berry, and snowberry are present in the stand but did not occur on sample plots.

The herbaceous understory has been altered by grazing. Reed canary-grass, the dominant understory in adjacent ungrazed stands has been reduced. Moneywort dominates the herbaceous vegetation. Kentucky bluegrass and Mediterranean barley are noted as the only other grasses associated with the stand.

Sedges, mouse-eared chickweed, dove-foot geranium, green dock, sticky purple geranium, and bull thistle are other species common to the under-story layer.

Ground coverage: Live vegetation 1 percent, litter 86 percent, bare ground 12 percent

Grazing pressure: Heavy

Table 43. Vegetative composition of intensive sampling area 3 (ash / willow / cottonwood), segment 3.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Black cottonwood	tree	20	33	5	95	8	--	--	--
Oregon ash	tree	100	79	95	64	10	--	--	--
Pacific willow[3]	tree	--	--	--	--	--	--	--	--
For all trees[1]	--	--	--	--	65	10	190	15.32	235
Wild trailing blackberry	shrub	50	9	--	3	--	770	--	--
Oregon ash	shrub	20	5	--	5	--	70	--	--
Black cottonwood	shrub	20	--	--	3	--	30	--	--
Blue bindweed[3]	shrub	--	--	--	--	--	--	--	--
Himalayan berry[3]	shrub	--	--	--	--	--	--	--	--
Snowberry[3]	shrub	--	--	--	--	--	--	--	--
Moneywort	forb	90	0.6	--	--	--	--	--	--
Carex spp.	forb	25	0.1	--	--	--	--	--	--
Wood buttercup	forb	5	0.05	--	--	--	--	--	--
Mouse-eared chickweed	forb	25	0.1	--	--	--	--	--	--
Sticky purple geranium	forb	5	0.05	--	--	--	--	--	--
Dove-foot geranium	forb	5	0.05	--	--	--	--	--	--
Bull thistle	forb	5	0.05	--	--	--	--	--	--
Clustered dock	forb	10	0.05	--	--	--	--	--	--
Purslane speedwell[3]	forb	--	--	--	--	--	--	--	--
Wild carrot[3]	forb	--	--	--	--	--	--	--	--
Small hop clover[3]	forb	--	--	--	--	--	--	--	--
Stinging nettle[3]	forb	--	--	--	--	--	--	--	--
Tansy ragwort[3]	forb	--	--	--	--	--	--	--	--
Candy flower[3]	forb	--	--	--	--	--	--	--	--
American winter cress[3]	forb	--	--	--	--	--	--	--	--
Western buttercup[3]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	45	0.25	--	--	--	--	--	--
Kentucky bluegrass[3]	grass	--	--	--	--	--	--	--	--
Mediterranean barley[3]	grass	--	--	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.

Sampling area: 5, segment 3

Habitat: Large willow (Pacific willow / blue bindweed / reed canarygrass)

Location: Oregon shore; RM 130; S.W. ¼ S. 21, T. 1 N., R. 1 E. Rooster Rock State Park. Bordered by shrub willow on the north and west, by sandy shoreline of the river on the east, and a stand of mixed bigleaf maple, ash, cottonwood, and Douglas fir on the south.

Size of area: Approximately 450 yards by 70 yards

Slope: None

Aspect: None

Elevation:

Soil: Sandy loam mixed with large amounts of organic matter

Vegetation: The canopy consisted predominantly of Pacific willow and Columbia River willow, with average heights of 46 and 29 feet respectively (Table 44). A few isolated Oregon ash trees also occur in the stand. The stand has a tree density of 326 plants/acre of trees with an average dbh of 8 inches.

Blue bindweed, also called climbing niteshade, occurs throughout the stand. This woody vine tends to grow tangled among neighboring vegetation. Columbia River willow and creek dogwood are the only other shrub species present.

Reed canarygrass dominates the herbaceous layer in most portions of the stand. The grass was near six feet tall when sampling was done in late July. Yellow sedge, equisetum, and cleavers occur primarily in low, moist areas exposed to flooding.

Ground coverage: Live vegetation 2 percent, litter 83 percent, bare ground 15 percent

Table 44. Vegetative composition of intensive sampling area 5 (large willow), segment 3.

SPECIES	LIFE FORM	PERCENT FREQ	PERCENT[2] COVER	RELATIVE DENSITY PERCENT	MEAN HEIGHT (ft)	MEAN D.B.H. (in)	DENSITY PLTS/ACRE	MEAN DISTANCE	MEAN[2] AREA (ft)
Oregon ash	tree	--	4	--	--	--	--	--	--
Pacific willow	tree	100	54	72	46	8	--	--	--
Columbia River willow	tree	60	28	27	29	6	--	--	--
For all trees[1]	--	--	--	--	41	8	326	11.56	134
Columbia River willow	shrub	10	7	--	12	--	10	--	--
Blue bindweed	shrub	30	5	--	2	--	180	--	--
Creek dogwood[3]	shrub	--	--	--	--	--	--	--	--
Yellow sedge	forb	50	0.25	--	--	--	--	--	--
Carex spp.	forb	20	0.01	--	--	--	--	--	--
Equisetum spp.	forb	20	0.05	--	--	--	--	--	--
Cleavers	forb	5	0.05	--	--	--	--	--	--
Field mint[3]	forb	--	--	--	--	--	--	--	--
Stinging nettle[3]	forb	--	--	--	--	--	--	--	--
Giant hedge nettle[3]	forb	--	--	--	--	--	--	--	--
Northern bedstraw[3]	forb	--	--	--	--	--	--	--	--
Potentilla spp.[3]	forb	--	--	--	--	--	--	--	--
Blunt-leaved winter cress[3]	forb	--	--	--	--	--	--	--	--
Small-flowered willow-weed[3]	forb	--	--	--	--	--	--	--	--
Reed canarygrass	grass	100	0.68	--	--	--	--	--	--

[1]Combined data for all species of trees.
[2]Basal area for forbs, canopy cover for trees and shrubs.
[3]Species was present in stand but did not occur in sample plots.