INVENTORY OF RIPARIAN HABITATS

AND ASSOCIATED WILDLIFE ALONG COLUMBIA AND SNAKE RIVERS

U.S. ARMY CORPS OF ENGINEERS
NORTH PACIFIC DIVISION
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INVENTORY OF VEGETATION AND WILDLIFE IN RIPARIAN AND OTHER HABITATS ALONG THE UPPER COLUMBIA RIVER

to

U.S. Army Corps of Engineers

Wildlife Work Group

from

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ABSTRACT

The development of the Columbia-Snake River hydropower complex has flooded much of the original river bottom. Changes in river flows and pool levels continue. Since these might affect shoreline vegetation and associated wildlife the present study was undertaken to describe vegetation and wildlife, make preliminary assessments of water fluctuations on these, and describe current human use.

The University of Washington portion of the study covered the Columbia from Richland north to Canada, about 400 river miles. This region was broken into ten segments from south to north; Hanford (free flowing); Priest Rapids pool; Wanapum pool; Rock Island pool; Rocky Reach pool; Wells pool; Rufus Woods pool (Chief Joseph Dam); south F.D. Roosevelt pool; north F.D. Roosevelt pool; and the free flowing northern segment.

For each segment the main habitat types (riparian, shrub, grassland, conifer, etc.) were systematically described and sampled for wildlife through the year. The main game species were mule and white-tailed deer, elk, pronghorn antelope, black bear, cottontail, black-tailed jack rabbit, California quail, pheasant, chukar partridge, gray (Hungarian) mallard and Canada goose.

The recorded bird species on the Audubon Society's Blue List (dwindling)are: Swainson's, Ferruginous, Cooper's, Sharp-shinned and Marsh hawks, Prairie Falcon, Kestrel, Osprey, Burrowing and Barn Owls.

The recorded mammal species listed as rare by The Wildlife Society are: Ord's kangaroo rat and lynx.

Many other species of birds, mammals, reptiles and amphibians were found.

Of the various shoreline habitats, the riparian shrub and tree communities are the most valuable and the most limited. The original riparian habitat has been flooded. The present impoundments range from 8 to 42 years since flooding, and new riparian development around even the oldest is only partial. Evidently the spontaneous development of riparian vegetation is extremely slow. It appears to be inhibited by heavy wave action and possibly water-level fluctuation.

However, prospects for increasing riparian vegetation through management appear promising. Such practices as planting cuttings and creating protected shorelines should show rapid response. With an increase in riparian shrub and tree associations, carrying capacity for a wide diversity of wildlife species would be raised.

Most human uses of the river are wildlife-related in that wildlife constitutes an important part of the recreational environment. Increasing wildlife populations would increase the quality of recreational experience along the Columbia not only for hunters, but for fishermen, beachcombers, swimmers, and many other persons enjoying the natural scene.

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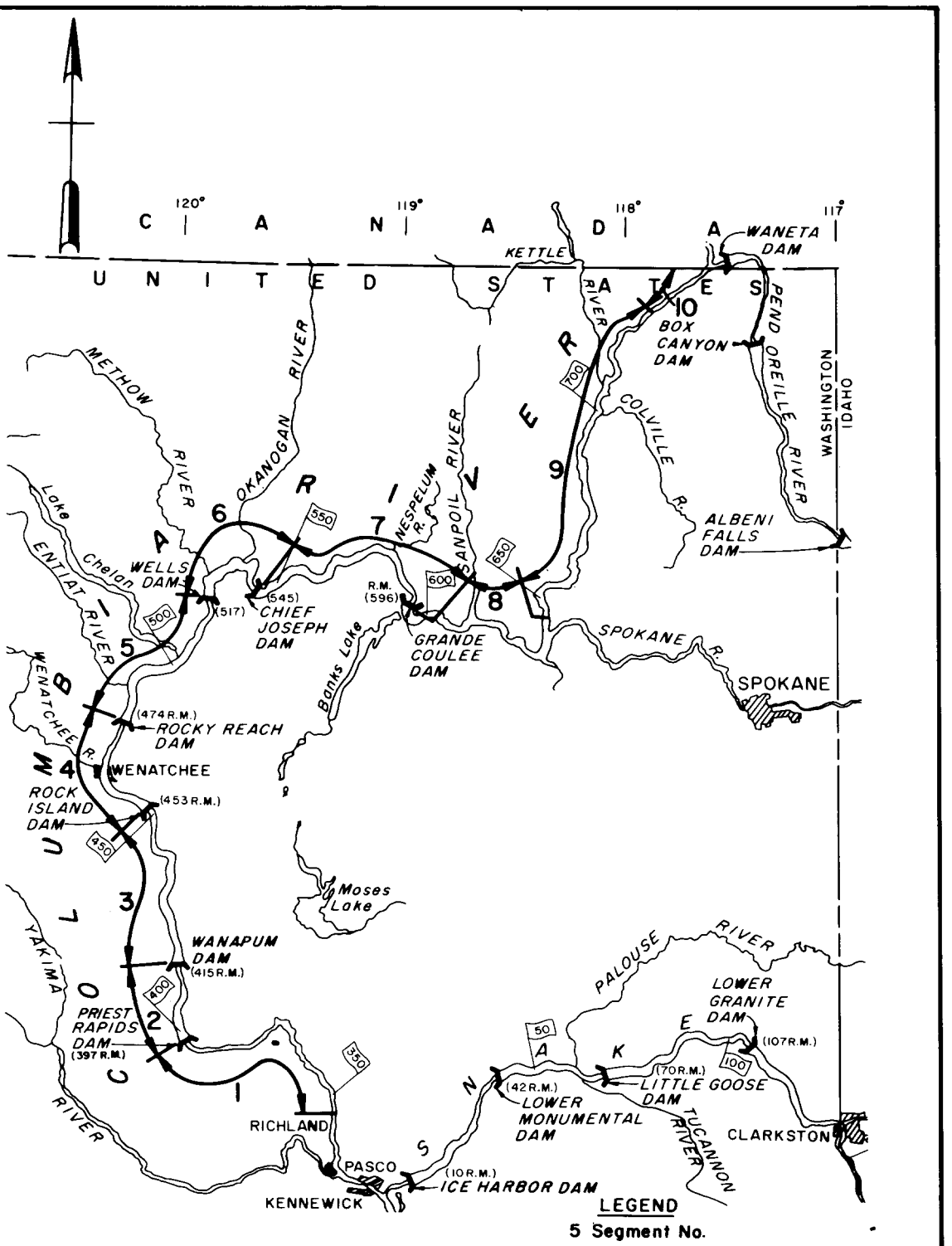


NOT TO SCALE

FISHERIES ENGINEERING RESEARCH PROGRAM
INVENTORY OF RIPARIAN HABITATS
1973–1975
UNIVERSITY OF WASHINGTON
STUDY AREA
COLUMBIA RIVER
RM 345.5 TO RM 745
U.S. ARMY ENGINEER DISTRICT, WALLA WALLA

INTRODUCTION

Plans have been made by the North Pacific Division of the U. S. Army Corps of Engineers to coordinate operation of the dam on the Columbia River and middle and lower Snake River to maximize hydroelectric production. These plans already are in effect in some places.

Each adjustment in production means changes in river flows and pool levels. The potential effects of these flows and levels on the wildlife populations using the waters and shores are of concern to the Corps and to the Wildlife Working Committee. The Wildlife Working Committee, which advises the Corps in the region on wildlife-related matters, is constituted of representatives from the State Departments of Game of Washington, Oregon, and Idaho and the U. S. Fish and Wildlife Service. Upon studying the question of the consequences of changes in water regime, the Committee concluded that knowledge of the wildlife populations using the waters and shore would need to be more exact before further conclusions could be drawn. Accordingly, the Committee suggested an extensive inventory of all vertebrate wildlife, exclusive of fish, of the waters and shores, along with preliminary assessments of proposed river regulation impacts upon riparian habitats and wildlife.

SCOPE OF THE PROJECT

The Corps solicited a study proposal from UW, OSU and UI for coordinated study. In response, a study plan was submitted on September 30, 1973. It was entitled, INVENTORY OF RIPARIAN HABITATS AND ASSOCIATED WILDLIFE ALONG THE COLUMBIA AND SNAKE RIVERS.

The region was divided geographically, the UW taking responsibility for that portion of the Columbia River from Richland north to the Canadian border -- some 400 river miles.

The period for this study, including preparation of reports, was between April 23, 1973 and December 31, 1975.

OBJECTIVES

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

2. Identify the wild vertebrates, excluding fish, using these habitats, and establish indices and make population estimates where possible.

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

4. Incidental to objectives 1 and 2, determine to a limited extent the wildlife-related use by people using the upper Columbia River.

PURPOSE OF STUDY

The purpose of the study was to determine what wildlife used the study region, and the extent to which the various populations were affected by the water and its fluctuations, directly or indirectly. Since the study area was large, and the time for field work short, the level of resolution was necessarily coarse.

AREA OF STUDY

The study region was stratified on the basis of major plant communities, on the well-founded assumption that plant communities commonly support characteristic wildlife species. Of the plant communities bordering the river, most emphasis was placed on those which were most strongly affected by water levels -- i.e. the riparian vegetation. The basic sampling unit was the 1000 meter transect, and an attempt was made to establish one transect within each major plant community for each pool. Some 70 transects were established, described with respect to location and vegetation, and used as sample units in the seasonal inventory of vertebrate populations. In addition, habitats lying outside the communities sampled in these transects were described and studied at lower levels of intensity.

In addition, the study region was divided into lineal segments, mostly impounded pools, since there is little free-flowing river in our region.

DESCRIPTION OF STUDY AREA

The upper Columbia River study area extended from the British Columbia border downstream to river mile (RM) 345.5 between islands 17 and 18 (Hanson and Eberhardt 1971) just north of Richland, Washington -- a distance of about 400 miles (640 km). Including islands and tributaries affected by dam operations, there was about 900 miles (1400 km) of shoreline to be inventoried. The area was divided into the following segments: (1) Hanford, from RM 345.5 to Priest Rapids Dam; (2) Priest Rapids reservoir; (3) Wanapum reservoir; (4) Rock Island reservoir; (5) Rocky Reach Reservoir (Lake Entiat); (6) Wells reservoir; (7) Rufus Woods Lake (Chief Joseph Dam) reservoir; (8) South FDR, from Grand Coulee Dam to RM 640 just north of the Spokane River; (9) North FDR, from RM 640 to RM 730 just south of Northport; (10) British Columbia (= Northern Free-flowing Segment), from RM 730 to the British Columbia border. Except for segments 1, 8, 9, and 10, all segments coincided with the dammed reservoirs and their individual hydro characteristics (Tables

1 and 2). The Hanford and British Columbia segments were free flowing, except as influenced by Priest Rapids Dam, and Waneta Dam in British Columbia, respectively. The division of Lake Franklin D. Roosevelt into South FDR and North FDR was justified mainly on the basis of latitude and habitat change -- South FDR extending generally east and west with abundant shrub steppe vegetation; North FDR extending generally north and south with abundant coniferous vegetation.

The shoreline extension of the study area included the area within 10 feet (3 m) elevation above highest water levels. In some cases it was higher, particularly along Lake Franklin D. Roosevelt where water level fluctuation promotes extensive land slide areas (see Table 79) affecting habitat 120 feet (35 m) or more above water. All portions of islands were included regardless or relief and vegetative patterns. All Corps of Engineers project lands adjacent to the shoreline were included.

Since the control of the upper Columbia and administration of its shoreline is influenced by no less than 17 different agencies, we found it necessary to contact them to explain the study and obtain cooperation and permission to work in their areas of jurisdiction, despite the fact that our contract to proceed was in effect already. These agencies are:

U.S. Bureau of Reclamation
U.S. Park Service
U.S. Forest Service
U.S. Fish and Wildlife Service
U.S. Army Corps of Engineers (Seattle District)
U.S. Army
U.S. Atomic Energy Commission
Battelle Northwest
Colville Indian Reservation
Spokane Indian Reservation
Douglas County PUD
Chelan County PUD
Grant County PUD
Washington Department of Game
Washington Department of Natural Resources
Washington Parks and Recreation Commission
Burlington Northern Inc.

We also had to contact private landowners whenever we wanted to locate transects or otherwise travel on private land.

Initially, permission was granted by all agencies except the AEC Hanford Reservation and the Colville Indian Reservation. Ultimately, the AEC issued us passes and dosimeters which enabled us to proceed on their land; the Colville Confederated Tribe granted permission after consulting with us concerning a similar study they have contracted with the Seattle, District Office of the U.S. Army Corps of Engineers, concerning the raising of Rufus Woods Lake.

Table 1. Hydroelectric projects corresponding to study area segments of the upper Columbia River.

Project	Owner	In Service Date	Units	Draw-down (ft.)	Length of Reservoir (mi.)	Length of Shoreline (miles): Island	Mainland	Total	No. of Transects: Land	Boat
Hanford Res	AEC	-	-	-	51.5	39.3	116.7	156	10	2
Priest Rapids	Grant Co.	1959	10	6.5	17.9	1.2	46.8	48	3	2
Wanapum	Grant Co.	1963	10	11.5	38.4	5.7	83.3	89	4	3
Rock Island[a]	Chelan Co.	1933	10	4.0	21.1	0.0	43.0	43	4	1
Rocky Reach	Chelan Co.	1961	11	4.0	42.1	2.7	90.3	93	7	2
Wells	Douglas Co.	1967	10	8.0	28.5	6.6	121.4	128	5	1
Chief Joseph[a]	Corps	1955	16	6.0	51.5[b]	2.0	127.0	129	6	2
Grand Coulee[a]	U.S.B.R.	1941	18	82.0	148.8[b]	2.1	340.88	342.98[b]	19	1
TOTAL					399.8	59.6	969.38	1028.98	58	14

[a]Rock Island: Second powerhouse with eight units presently under construction and scheduled for operation beginning 1978, will increase electrical output 310 percent. The 10 generators in the existing powerhouse are being rewound to increase electrical output. Pool will be raised 6 feet.

Chief Joseph: Eleven more units, under construction and scheduled for operation beginning 1981, will increase electrical output 108 percent. Pool will be raised 10 feet.

Grand Coulee: Third powerhouse, with six units under construction and scheduled for operation beginning 1975, will increase electrical output 182 percent. Room for another six units is available in the third powerhouse, but they are not yet authorized. The 18 generators in the existing two powerhouses are being rewound to increase electrical output. In addition, six more pipes are being installed, for a total of 12, to pump water to Banks Lake for irrigation. These six are reversible and will have generating units.

[b]For this study, Lake F.D.R. is divided into two segments -- South F.D.R. from Coulee Dam to the Spokane River (43.4 river miles) with six land and one boat transects, North F.D.R. from the Spokane River to RM 730 (99 river miles) with 6 land transects, and British Columbia from RM 730 to the British Columbia border (15 river miles).

Table 2. Project operating extremes 4 month summary (Dec, Apr, Jun, and Aug 1971). (From Subcommittee on Environmental Impact of River Regulation 1972).

	FOREBAY				TAILWATER			
	Elevation-Ft.		Rate-Ft/Hr.		Elevation-Ft.		Rate-Ft/Hr.	
Project	Maximum	Minimum	Max. Increase	Max. Decrease	Maximum	Minimum	Max. Increase	Max. Decrease
Priest Rapids	491.7	481.5	1.0	0.9	423.6	401.9	6.5	4.4
Wanapum	575.0	561.6	0.7	0.8	502.0	484.2	3.5	3.0
Rock Island	606.8	603.4	1.5	1.2	583.3	564.0	2.5	2.2
Rocky Reach	710.0	703.0	1.0	1.0	629.0	605.0	4.6	3.6
Wells	779.5	769.0	0.8	0.7	726.5	704.2	9.8	9.2
Chief Joseph	946.3	940.6	1.8	1.4	792.1	771.2	6.0	3.4
Grand Coulee	1290.0	1211.6	0.2	0.2	973.6	945.8	3.8	2.5

	GENERATION				TOTAL OUTFLOW			
	Megawatts		Rate MW/Hr.		KCFS		Rate/KCFS/Hr.	
Project	Maximum	Minimum	Max. Increase	Max. Decrease	Maximum	Minimum	Max. Increase	Max. Decrease
Priest Rapids	897	222	287	270	357.0	36.0	56	64
Wanapum	969	59	367	290	366.6	10.1	67	60
Rock Island	200	75	54	57	364.5	34.0	92	49
Rocky Reach	799	190	250	269	345.2	27.5	60	56
Wells	842	0	380	360	337.4	17.0	60	68
Chief Joseph	1296	116	692	750	305.8	15.8	82	58
Grand Coulee	2305	497	766	792	299.4	26.8	31	30

Three construction operations in the upper Columbia complicated our study. (1) The USBR is installing a third powerhouse for electricity and additional pumping units to Banks Lake for irrigation and electricity (see Table 1). From February-May 1974, Lake FDR was lowered 120 feet below maximum pool elevation (1290 feet) and 48 feet below minimum pool elevation (1208 feet) to facilitate earth removal for spilling water behind the third powerhouse. (In fact, Kettle Falls was visible during this period, and provided opportunity for archeological work and tourism). The USBR is considering conducting some type of study to determine what impact the third powerhouse will have on and along Rufus Woods Lake. (2) The U.S. Corps of Engineers is installing additional units in Chief Joseph Dam, and will raise the pool 10 feet (see Table 1). The Corps has contracted with the Colville Indian Reservation to determine the effect of fish, wildlife, and recreation on both banks of Rufus Woods Lake. The Colville Indian Reservation has sub-contracted with the University of Washington College of Fisheries for the fish and wildlife aspect, and with a Spokane consulting firm for the recreational aspect. We have collaborated with the UW College of Fisheries. (3) Chelan County PUD is constructing a second powerhouse in Rock Island Dam, and will raise the reservoir 6 feet (see Table 1). They have contracted with the Washington Department of Game to study the effect on associated wildlife. We have collaborated.

In addition to all of this, the National Park Service is interested in an inventory similar to ours in Coulee Dam National Recreation Area surrounding Lake FDR from Coulee Dam to Onion Creek (near Northport). We have consulted with them, and our sampling intensity, though low, and methods apparently will satisfy their requirements. Also, the Seattle District of the Corps of Engineers, and Chelan, Douglas and Grant County PUD's contracted with the Seattle consulting firm of Wright, Gildow, Hartman, Teegarden Architects and Planners to obtain recommendations on tourist attraction and determine tourist potential along the Columbia River. The firm submitted their report "Stewards of the River" to the contracting agencies.

A partial chronology of field work will serve to illustrate the seasonal sampling scheme.

June 1973 - literature review
July 1973 - reconnaissance of entire study area
August 1973 - study plan
October 1973 - bird inventory at Richland
November 1973 - aerial waterfowl census, bird trend inventory on 4 plots
April 1974 - confirmed aerial photos, waterfowl aerial census of study area
May 1974 - inventory vegetation, breeding birds, small mammals (May 16 - June 30)
July 1974 - bat and reptile survey
August 1974 - bat and reptile survey
October 1974 - fall migratory bird inventory, fall mammal inventory, aerial waterfowl survey

November 1974 - fall mammal inventory, aerial waterfowl survey
January 1975 - winter resident bird survey, monthly waterfowl aerial census, monthly big game aerial census
February 1975 - winter resident bird survey, monthly waterfowl census, aerial big game census
April 1975 - collected shrub density on all transects, counted pellet groups, mapped riparian vegetation, counted raptors
May 1975 - finished mapping shoreline vegetation, raptor inventory

LITERATURE REVIEW

Geology

In the Washington study area the Columbia River runs through or borders on three of the state's seven physiographic provinces. These are the Okanogan Highlands, the Columbia Basin, and the Cascade Mountains (Livingston 1969).

Little is known of the geology of the Okanogan Highlands, or indeed of any of the provinces, prior to the Cambrian Period. It is believed, however, that the area was under a shallow sea for much of that era (Livingston 1969).

During the Paleozoic era and the early Mesozoic, the area continued to be under water, and sedimentary accumulation occurred during this time.

In the Cretaceous period metamorphism began to occur, accompanied by thrust faulting which expelled the sea from this and the Columbia Basin province (McKee 1972). After this uplift, stream erosion reduced the area to one of low relief by the middle of the Cenozoic era (approximately 30 million years ago).

The present topography of the Highlands has been formed since the latter part of the Cenozoic by uplift, increased erosion, and then glaciation during the Pleistocene epoch.

The present geology of the province is fairly complex. Some of the more extensive rock types through which the Columbia flows are Paleozoic sedimentary rocks, glacial deposits and recent alluvium, and along the southern edge of the province Mesozoic and early Tertiary granitic rocks (Livingston 1969).

The geologic history of the Columbia Basin province can only be traced back about 15 million years because the extensive lava flows of the Miocene epoch have obscured most of the earlier land forms (McKee 1972). At this time (13-25 million years ago), lava flowed out from great fissures and over a period of thousands of years, many separate flows built up a broad plateau which is up to 6000 feet thick in places. Later, during Pleistocene times, glaciation and its effects created many of the geologic features seen on the plateau today. As the continental ice

sheet moved south, a lobe of it blocked the Columbia River which subsequently formed a lake and then spilled over the valley sides flowing southwest helping to form Grand Coulee.

At about this same time, another lobe of the ice sheet blocked the Clark Fork River in northwestern Montana, creating an immense lake. Evidently this ice dam broke suddenly, releasing up to 50 cubic miles of water over a short period of time. This flood moved southwest, eroding and cutting as it went, forming the channeled scablands of the Columbia Basin. In addition, some of the water flowed west along the Spokane and Columbia River drainages and then southwest through Grand Coulee, deepening and broadening this channel.

The present day geology of the region is comparatively simple, consisting mainly of Miocene volcanic rocks with some sediments between beds, some areas of glacial deposits and alluvium, and large areas of Quaternary eolian and lacustrine deposits (Livingston 1969).

As with the other two provinces, the Cascade Mountain province was alternately exposed and submerged during the Precambrian Paleozoic, Mesozoic, and early Cenozoic eras. During the Pliocene epoch, the mountains began to be uplifted. Pleistocene glaciation subsequently formed much of the rugged topography evident today in this province (Livingston 1969).

The present day geology of the Cascade Mountain province where it touches on the study area consist of some pre-Jurassic metamorphic rocks, Cretaceous and Paleocene continental deposits, and Mesozoic and early Tertiary granitic rocks (Livingston 1969).

In the study area, several types of soils are encountered. In the Okanogan Highlands province, zonal Western Brown Forest and Brown Podzolic soils are found (Anonymous 1964). The Western Brown Forest soils are found in forest-grassland transition areas. Carbonate accumulations may be found in the upper C or lower B horizons. Brown Podzolic soils are fairly acid.

In the Columbia Basin province Brown Chestnut and Prairie soils are found in grasslands while azonal Regosols and zonal Sierozem soils exist in drier shrub-grassland areas.

In the Chestnut and Sierozem soils, carbonate accumulations occur in the lower B horizon. Regosols are usually quite thin and are found on sand and gravel stream outwash areas.

Man has existed in the vicinity of the study area for at least 12,000 years, having come from Siberia over a land bridge across the Bering Straight (Daugherty 1956). Evidently, he engaged in a hunting and gathering way of life (Sanders and Marino 1970).

The first white men to observe the study area were Lewis and Clark who hit the Columbia near Pasco and then proceeded downstream (Bakeless 1947).

The first thorough exploration of the area was undertaken by David Thompson and his party who were in search of beaver for the fur trade. They arrived at Kettle Falls in July 1811 and proceeded by boat downstream to the mouth of the river by August of that year (Holbrook 1956). That same month a party of Astor Fur Company employees entered the Columbia Basin area from the south, arriving on the 16th (Ross 1849).

The Astorians proceeded upstream until they reached the mouth of the Okanogan River on the 31st, encountering friendly Indians all the way. From here they explored up the Okanogan and into Canada, finally descending the Columbia in February of 1812. The Astorians sent several other parties up the river to the Okanogan in search of furs in subsequent years.

A mission was set up by the Whitmans near Walla Walla in the early 1800's and the town itself grew up a little later. Actual settlement on the river did not occur until the latter half of the 19th century. The first permanent settler did not come to Wenatchee until 1871 and the town of Entiat was not founded until 1888 (Hull 1929). After this time, however, the population of the area increased fairly rapidly.

The first industry of the area was agriculture. By the early 1900's fruit growing began to develop in the lower portion of the study area and logging probably got started in the Okanogan Highlands region at this time also.

Agriculture increased in importance in the basin area in the early and mid-20th century when construction of hydroelectric projects provided irrigation and electric resources. The first dam was built at Rock Island near Wenatchee in 1931 (Holbrook 1956). This was follwed by Grand Coulee in 1942. Through the 40's, 50's, and 60's, other dams followed until only one short free flowing stretch of the river remained (see Table 1). The water from these dams has irrigated thousands of acres of formerly semi-arid land, providing the basis for an extensive agricultural industry in the Columbia Basin.

Climate

The climate of the study area is most conspicuously affected by the fact that it is situated on the lee side of the Cascade Mountains. Consequently, the area is characterized by little annual precipitation, and extremes in temperature (Table 3). Most precipitation occurs during the winter and early spring, and the summers are hot and dry with heavy winds occurring in late spring and early summer (Hanson and Eberhardt 1971).

Flora

Four major vegetational zones occur in the study area. Proceeding northward from Richland they are: (1) shrub-steppe (with big sagebrush), (2) steppe (lacking big sagebrush), (3) Ponderosa pine and (4) a broad zone supporting Douglas-fir and grand fir as the principal dominants (Franklin and Dyrness 1973).

The first and largest of these zones is dominated by an Artemisia tridentata-Agropyron association which extends from the southern terminus of the study area to approximately the confluence of the Columbia and Sanpoil Rivers (Daubenmire 1970). This association is characterized by four well-defined layers: (1) shrub layer 10-20 dm high and dominated by Artemisia tridentata var. tridentata and lesser amounts of Chrysothamnus viscidiflorus, C. nauseosus var. albicaulis, Artemisia tripartita or Grayia spinosa (2) caespitose grasses 4-6 dm high, with Agropyron spicatum as the major species and varible amounts of Stipa comata, S. thurberians, Poa cusicki or Sitanion hystrix (3) a layer less than 1 dm high dominated by the perennial, caespitose grass, Poa secunda; annuals are best represented in this layer and in order of descending frequency Bromus tectorum, Festuca pacifica, Lappula redowskii, Descuraiania pinnata, and Gilia minutiflora, and (4) a surface crust composed of crustose lichens, acrocarpous mosses, and occasionally liverworts (Doubenmire 1970, Franklin and Dyrness 1973).

The second vegetational zone is the steppe which supports an Artemisia tripartita-festuca association. It is characterized by a discontinuous layer of Artemisia tripartita with Eriogonum heracleoides, Chrysothamnus spp. and Tetradymia spp. occurring irregularly. A dense layer of grass and grass-like plants (Festuca idahoensis, Agropyron spicatum, Carex filifolia, and Poa secunda) and a variety of forbs (Lupinus sericeus, Erigeron corymbosus, and Achillea millefolium) also occur (Doubenmire 1970, Franklin and Dyrness 1973).

In the Pinus ponderosa zone, six associations have been recognized: (1) Pinus ponderosa-Symphoricarpos albus, (2) Pinus ponderosa-Physocarpus malvaceus (3) Pinus ponderosa-Festuca idahoensis, (4) Pinus ponderosa-Agropyron spicatum, (5) Pinus ponderosa-Stipa comata, and (6) Pinus ponderosa)Purshia tridentata. The first two associations represent a shrubby group found on deep, heavy-textured, more fertile soils. The last four represent a grassy group found on stony or coarse-textured soils.

The last vegetational zone supports Pseudotsuga menziesii and Abies grandis associations. Both species occupy more mesic habitats than does Pinus ponderosa, and their elevational order of occurrence is usually Pinus ponderosa, Pseudotsuga menziesii, and Abies grandis. In the absence of Pinus ponderosa, Pseudotsuga menziesii will border the steppe or shrub-steppe zones (Franklin and Dyrness 1973).

The scarcity of riparian vegetation within the study area has been pointed out by O'Farrel and Hedlund (1972), but with the exception of the southern section, little work has been done to inventory that which does exist (Hanson and Eberhardt 1971). St. John and Jones (1928) characterized the riverbank vegetation of the southern free-flowing section in the following manner:

Trees	Herbs
Crataegus douglasii	Asclepias speciosa
Populus hastata	Badens cernua
Populus tremuloides	Coreopsis atkinsoniana
Salix amygdaloides	Eleocharis palustris
Salix candata	Eleocharis monticola var. pallida

Table 3. Climate regime of selected reference points along the upper Columbia River, 1931-1960. All temperatures are in degrees Fahrenheit.

Month	Colville			Wenatchee			Kennewick		
	Average daily			Average daily			Average daily		
	Min.	Max.	Record	Min.	Max.	Record	Min.	Max.	Record
March	27.3			30.8			35.7		
April	33.8						41.0		
May	40.9			47.6			48.2		
June	46.5	76.8	98(1936)	54.3	78.7	102(1948)	53.7	83	105
July	49.4	86.5	106(1934)	54.3	87.5	110(1941)	58.9	91.4	115(1939)
August	47.2	84.5	102(1930)	56.8	86.2	104(1941)	56.8	88.6	106(1942)
September	41.8	74.5	99(1950)	48.9	78.1	98(1935)	59.6	80.0	100
October	34.5			38.7			41.4		
November	27.2			29.4			32.3		0(1955)
December	22.5			25.2		-2(1932)	30.0		-8(1932)
January	16.9		-29(1950)	19.3		-17(1950)	23.5		-27(1930)
February	20.1		-29(1933)	22.2		-18(1950	28.0		-23(1950)
Days max. temp. is 32 and below	37			29			19		
Days min. temp, is 32 and above	162			127			95		
Yearly mean precipitation	17.35 inches			9 inches			7.37 inches		
Yearly average max. temp.	59.0			62.0			65.6		
Yearly average min. temp.	34.0			39.8			4.15		

Shrubs

Clematis ligustifolia
Philadelphus lewisii
Rhus glabra
Salix bebbiana
Salix exigua
Salix lutea
Salix scouleriana

Herbs

Elymus condensatus
Glycyrrhiza lepidota
Solanum dulcamara
Xanthium italicum
Carex spp.
Eyperus spp.

Plant species known to occur in the study area are listed in Apprendix 4.

Fauna

Early archeological records indicate that natives of the Columbia drainage used deer, elk, bighorn sheep, mountain goat, and pronghorn antelope as food sources. Marmot, beaver, and rabbit remains were also found (Grabert 1968). Osborne (1953) has found artifacts indicating bison also occurred in the Columbia Plateau. Ross (1849) reported beaver to be locally abundant. In one area near Priest Rapids, he noted that rattlesnakes were particularly abundant.

During the century of European settlement some nature forms have been reduced, mainly by losses in habitat, and several exotic species have been introduced. These latter include the ring-necked pheasant, Hungarian (= gray) Partridge, Chukar Partridge, California (= valley) Quail, and Merriam's Turkey.

Representative population figures for game populations subject to harvest were presented by the State Game Department in evaluating pre-impoundment populations for the Wells Dam project. Unless otherwise indicated, figures represent summer and winter estimates, respectively: ring-necked pheasant 1718-970, valley quail 19,120-8939, chukar 3075 (winter only), cottontail rabbit 610-970, Mourning Dove 69,275-47, ducks 1484 (fall)-4620 (winter), Canada Geese 466 (spring only), deer 50 (summer only). Comparable figures outside the impoundment areas were significantly lower.

Yocom (1949) found that Canada Geese bred along the Columbia River from its junction with the Okanogan River south; however, he also stated that geese did not breed on the river prior to the coming of white men (Yocom 1967). Pressure from harvest by white men apparently forced those birds onto the river. Hanson and Eberhardt (1971) suggested that the goose population had increased in or near the Hanford Reservation as a result of protection from human predation primarily. They also noted, however, that from 1958 there has been a downward trend primarily from coyote predation. They found a 20-year average of 253 pairs of Canada Geese on their study area. Studies from 1953 to 1956 indicated that approximately 300 territorial pairs of geese nested on that part of the river running through the Hanford Reservation. Studies by Gilbert et al. (1972) indicated that the Hanford goose population has been on the decline for the past 19 years. Oliver and Barnett (1966) found a summer goose population of 466 individuals. They also found a winter population of 5000 ducks primarily Mallards. In some areas, the U.S. Fish and Wildlife Service indicated that nesting habitat

was being lost as a result of flooding in the Priest Rapids and Wanapum projects (Anonymous 1958). The Grant County Public Utility District, in rebuttal, claimed that the removal of islands in these two areas would in fact enhance waterfowl production by preventing nesting pairs from using areas subject to spring floods (Anonymous 1958).

Several studies have been done on native birds of the study area. Yocom (1956) found that Sage Grouse existed in the study area from the mouth of the Spokane River south along the Columbia River. The population appeared to be stable at that time; since then sagebrush was replaced by irrigated fields over sage areas.

Sharp-tailed Grouse, formerly the most abundant game bird in the state, is now much less evident. Yocom (1952) stated that this bird is now found between the mouth of the Methow and Spokane Rivers along the Columbia. He believed that the populations of Sharp-tailed Grouse declined because of the advent of intensive farming methods and the practice of burning stubble fields which were used as nesting sites.

Of the five species of grebes known to exist in eastern Washington (Eared Grebe, Pied-billed Grebe, Western Grebe, Horned Grebe, and the Red-necked Grebe), only two, the Pied-billed Grebe and the Eared Grebe, bred within the study area (Yocom 1958). The breeding area appeared to be limited to the area between the mouth of the Okanogan River and the mouth of the Spokane River. All five species can be found as migrants in the vicinity of Grand Coulee. The Eared Grebe was the most abundant with the Pied-billed, Western, Horned, and Red-necked grebes found in decreasing abundance.

Hanson (1963) reported nesting colonies of Ring-billed Gulls and California Gulls on islands in the river bordering the Hanford Reservation. Ring-billed Gulls were most numerous; on April 7, 1961, approximately 500 were present on an island, and on April 28, 2000 were present on the same site.

Four exotic game bird species (California Quail, Hungarian Partridge, Ring-necked Pheasant, and Chukar Partridge) are now well established. The California Quail was first introduced into Washington in 1914 in Walla Walla County (Crispens et al. 1960). One hundred eight birds were released at that time, followed by 12 in Garfield and 48 in Yakima Counties in 1915. At present the California Quail's range lies within the study area in the Wenatchee-Chelan area and again in the extreme northern portion of the study area.

The Hungarian Partridge was first introduced unsuccessfully in 1897 Yocom 1943). The next introduction occurred in 1906 in Spokane County when 250 pairs were released. This "plant" was also unsuccessful. In following years introductions were successful and the Hungarian Partridge became established. The bird can now be found throughout the study area.

The Ring-necked Pheasant was first introduced into Washington in 1883 (Lauckhart and McKean 1956). Eastern Washington stocking began between 1898 and 1900. At the present time, population densities are greatest in the southern portion of the study area and near Lake Chelan. Numbers drop off rapidly north of the Spokane River. Populations reached a high in the later 1920's and a low in the middle 1930's.

The Chukar Partridge was first brought to Washington in 1931 (Moreland 1950). Successive plants took place in 1932 and between 1938 and 1942. Table 4 indicated those counties with established populations within the study area. The chukar has also spread into Chelan County.

Mammal research is not extensive in the study area. Rickard (1960) found that four species of small mammals existed in the sagebrush and wheatgrass vegetational habitats of eastern Washington. These species were: (1) sagebrush vole (Lagurus curtatus), great basin pocket mouse (Perognathus parvus), western harvest mouse (Reithrodontomys megalotis), deer mouse (Peromyscus maniculatus).

In the pure coniferous forest zone, Rickard (1960) found the yellow pine chipmunk (Eutamias amoenus), gapper red-backed mouse (Clethrionomys gapperi), masked shrew (sorex cinereus), and the dusky shrew (Sorex obscurus). The gapper red-backed mouse was absent from the more xeric areas. O'Farrel (1972) encountered the sagebrush vole on the Hanford Reservation. Population distribution was between 1000 and 2000 feet in elevation and above 3500 feet.

Hedlund et al. (1973) stated that mule deer tagging studies have been carried out for the past 20 years on the Hanford Reservation. Results indicated that females preferred the islands of the Columbia River on the reservation as fawning areas. White-tailed deer have recently been observed on the Hanford Reservation (O'Farrel and Hedlund 1972). Such sightings indicate a range extension of that species.

Human Use of Wildlife Resource

Recreational hunting is now prevalent along the river system. In the area of the proposed Ben Franklin Dam (Segment 1 of the study area), a total of 9320 man-days were expended hunting big game, upland game and ducks, and geese a decade ago (Table 5). In the Wells project area (central portion of the study area), a total of 11,346 man-days were expended (Oliver and Barnett 1966).

Washington Department of Game harvest records are also available for wildlife recreational areas within the study area (Table 6) (Bens 1969).

Harvest data for counties within the study area are presented in Table 7 (Washington Department of Game, 1960 and 1972). These figures represent county-wide harvest only.

Table 4. Estimated 1950 Chukar Partridge populations

County	Population size
Benton	286
Douglas	521
Grant	310
Kittitas	390
Lincoln	190
Okanogan	100
Yakima	442

Table 5. Hunter use in two hydroelectric project areas

Animal Group	Estimated Annual Man-Days Proposed Ben Franklin Area	Wells
Deer	1,275	61
Upland Game	4,770	10,113
Geese	2,625	
Ducks	650	
Geese and ducks		1,172
	9,320	11,346

Table 6. Game harvested on wildlife recreation areas adjoining the upper Columbia River, 1969

Area	Waterfowl	Upland Game	Big Game
Colockum and Schaake	295	2198	122
Entiat	-	957	14
Priest Rapids	578	-	-
Sherman Creek	-	1319	33
Swakane	-	853	9

Table 7. Game harvests for 1960 and 1972 by county.

County	Deer	Elk	Pheasant	Duck	Geese
			1960		
Benton	6	-	22,920	13,910	3,470
Chelan	4,310	110	3,050	2,750	85
Douglas	750	-	4,740	5,600	430
Ferry	1,690	-	2,020	1,200	-
Franklin	20	-	17,750	16,050	3,990
Grant	340	-	64,430	85,000	6,760
Kittitas	2,550	-	14,210	8,070	20
Stevens	6,760	-	6,330	5,770	195
Total	16,480	110	135,450	138,350	14,950
			1972		
Benton	70	-	16,100	20,530	5,370
Chelan	620	150	2,610	4,820	240
Douglas	450	-	2,890	7,450	2,670
Ferry	650	-	350	1,430	110
Franklin	160	-	37,000	50,180	7,340
Grant	200	-	108,520	207,150	12,170
Kittitas	910	1,180	9,300	11,330	60
Stevens	2,730	-	2,590	4,900	90
Total	5,790	1,330	179,360	307,790	28,050

Effects of Water Fluctuation

Johnsgard (1955) found that use of potholes and ponds by waterfowl and other birds increased with a decrease in water fluctuation. Decreases were attributed to the following causes: (1) reduction of breeding habitat, (2) direct nest flooding, and (3) reduction of nesting cover. Very little data exists on the effects of water level fluctuation and its effect on plant and animal populations.

METHODS

The general approach to be used in conducting the research was to delineate existing broad vegetative types and land form classes within the entire study area and to stratify the sampling of vegetation, wildlife populations, and human use of wildlife resources by vegetative types and land form classes and geographical location.

Ordinarily, one intensive sampling area was established in each major vegetative type and land form class that occurred within each segment of the study area. Major vegetative types and land form classes that occur on both the left and right shores and on islands had sampling areas located within them whenever possible. Sampling areas were placed in homogeneous stands of vegetation and well inside their boundaries where feasible in order to avoid a possible "edge-effect." However, some vegetative types occur only in narrow "strips or patches."

Intensive sampling areas were used for sampling of vegetative communities and species of mammals, birds, reptiles and amphibians that require intensive sampling procedures. Species more suitable for extensive sampling procedures (i.e., waterfowl, shorebirds, cliff-nesting birds, aquatic fur-bearers, etc.) were sampled more generally through the study area. We identified habitat types for each segment via aerial photo interpretation, and boat, aerial, and ground reconnaissance. These habitat types, access to them, available manpower, and seasonal and daily activity patterns of the animals influenced the number and location of transects used for sampling the shoreline of the study area. Transects were located generally in groups of four to reduce travel time and allow completion of the bird inventory on the four transects by late morning of each day. At the same time, transects were separated usually by at least one km to avoid between-transect disturbance of birds especially. Working 10 days on and 4 days off and censusing each transect 2 days, the bird team was allowed 6 weeks to complete the inventory between the beginning and end of the migration and breeding periods. These limitations strongly influenced the number of transects selected. We inventoried vegetation and vertebrates on the same transects to facilitate correlation of wildlife use with habitat. These limitations in the selection of the sample size have resulted in an overview of our objectives rather than an intensive investigation. Seventy-two

transects were selected for sampling, of which 14 were boat and 58 were shoreline transects (see Table 1). Boat transects were run while traveling between land transects and data collected on birds observed were included as supplemental information. All transects were parallel with the shoreline.

The overall study was broken down as follows primarily on the basis of compatibility of sampling techniques: (1) delineation of broad vegetative types and land form classes; (2) description of specific vegetative communities; (3) inventory of big game; (4) inventory of small mammals and terrestrial furbearers; (5) inventory of waterfowl; (6) inventory of other birds; (7) inventory of bats; (8) inventory of reptiles and amphibians; (9) inventory of human use of wildlife resources; and (10) preliminary assessment of impacts of proposed river regulation on wildlife habitat and wildlife populations.

Vegetation

Delineation was accomplished by interpretation of aerial photographs and by ground search. Photographs used are 9 x 9 in. black and white prints (scale: 1:10,000 - 1:24,000) obtained from the U.S. Corps of Engineers. Dates of photograph coverage vary as to portion of the study area, with the most recent coverage being 1973, and the earliest 1966. Generally speaking, coverage of most of the study area is 1970 or later.

Broad vegetative types and land form classes identified from examination of aerial photographs and delineated on the photographs were verified by field observations made from air and/or ground checks.

Areas delineated on the photographs were identified with a code number designating a particular vegetative or land form classification. The size (acres) of delineated areas on islands was determined from the photographs or a vegetative map made from the photographs by using dot grids.

Narrow riparian strips characteristic of parts of the upper Columbia could not be identified through the aerial photo-interpretation. To determine the extent of the riparian areas, the river was traveled by boat from the British Columbia border to RM 345.5 near Richland, and all riparian strips and pockets were mapped on the aerial photo overlays. The number of contiguous strips of habitat type then was tallied by various lengths for every 5 river miles, and further compiled. Thus, the exact number and length of each habitat type was determined for each bank of each segment of the entire upper Columbia. In addition, each habitat type, as determined from photo-interpretation and river mapping, was measured on each island to determine area.

Upon entering the habitat, we recorded a list of all species observed to occur within that community or the transect. Upon completion of the initial list we began sampling as described above.

Each land transect was marked at each end with a 6-foot metal fence post and painted red with a white tip. Posts were driven in the ground beyond the flange -- a distance of 20-30 in. All land transects were photographed from one end for perspective, and to facilitate photographic comparison of future conditions.

After similar vegetative types are identified and delineated by photo-interpreters, the various types were field sampled on a sample area or stand basis. Field sampling involved the collection of quantitative data on specific vegetation attributes using recognized sampling methods.

Vegetation attributes measured in this inventory include: (1) species presence, (2) plant (basal and/or canopy) and ground coverage, (3) density, (4) frequency of occurrence (grasses, grasslikes, forbs, and/or low-growing shrubs) and/or "contact" (medium- and tall-growing shrubs and trees), (5) shrub and tree crown heights and diameters, (6) decadence, (7) tree bark type, (8) height of trunk to first branch.

Ground coverage estimates describe ground cover in terms of live vegetation, litter, rock, erosion pavement, and bare ground or soil.

Quantitative inventory data was obtained using recognized sampling methods including the canopy coverage by plot method (Daubenmire 1959) and the line intercept method (Canfield 1941). Line intercept data was collected only where it was required to complement the canopy coverage by plot data. The canopy coverage by plot method obtained plant coverage (canopy and/or basal), frequency of occurrence, ground coverage, and species presence of the grasses, grasslikes, forbs and low-growing shrubs. The corner leg hits of the plot frame provided the least biased estimate of ground coverage. The line intercept method is not as satisfactory as the canopy coverage method in the detection of various life forms of plants, especially forbs (Asherin 1973a and Daubenmire 1959). However, if ground rules define coverage as a vertical projection of the outline of undisturbed vegetation, both methods should yield comparable results. The line intercept method was thus used to obtain canopy coverage, frequency of "contact," and species presence on sites where medium- and tall-growing shrubs and trees are present. Frequency of "contact" values yielded species distribution or dispersion data similar to frequency of occurrence values obtained in the canopy coverage by plot method (Asherin 1973a).

Density counts (plants per unit area) for shrubs and trees were obtained using direct counts on circular and/or rectangular plots, and the point-centered-quarter method (Cottom and Curtis 1956). Actual species counts were obtained directly from aerial photos where feasible.

Short alpha symbols developed by Asherin (1973b) and Garrison, et al. (1967) were used for recording plant names on coded field forms.

Photoplots or points established at each intensive sampling area provided a permanent visual record of vegetative changes or lack of change and documented or illustrated quantitative measurements. Photoplots attempted to include some prominent landscape feature in the general view. Some microplots are also established in representative vegetative types to illustrate species coverage and presence changes.

Before intensive field sampling began, all study teams agreed to and abided by ground rules concerning sampling techniques.

To avoid inconsistencies among observers collecting vegetation data, the following set of "ground rules" was observed:

1. Canopy or foliage coverage was defined as a vertical projection of the outline of undisturbed foliage and was recorded for all shrubs, vines, and trees. Interspace(s) of individual plants were included in measurements.

2. Basal area was the area occupied by live plant parts at the ground surface or the area defined by live root growth and was recorded for all grasses, grasslikes and forbs. The basal area of plants with basal rosettes was understood to be the area defined by live root crowns only. Single-stemmed annuals were collectively grouped by species in an individual observation.

3. Bare soil was exposed mineral soil and stone particles up to 3/4-inch in diameter and well-dispersed stone particles up to 3 inches in diameter that do not provide a continuous cover. Stone particles from 3/4 to 3 inches in diameter forming a continuous cover on the soil surface was classified as erosion pavement. Stones larger than 3 inches in diameter at the soil surface were classified as rock. Litter was defined as dead organic material lying on the soil surface from previous years' growth (included animal droppings). Annual plants were classified as litter in ground cover estimates.

4. For "in-out" decisions -- anything marginal was OUT.

Wildlife

Big game

Species included in the category of big game are: elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), mountain goat (*Oreamnos americanus*), mountain sheep (*Ovis canadensis*), pronghorn (*Antilocapra americana*), black bear (*Ursus americanus*), and cougar (*Felis concolor*).

The occurrence of deer and elk on the study area was determined from direct observation of animals and by the presence of tracks and feces. Some low-lying areas supporting riparian vegetation and subject to flooding due to peaking operations were examined during mid-winter and mid-summer to determine what riparian zones are used. For the remainder of the study area, the occurrence of deer and elk by major vegetative types and land form classes and segment of the study area was estimated from presence of feces, tracks and direct observation of animals on the intensive sampling areas.

Pellet-group counts were made on heavily used sites for estimating deer-and elk-days and/or relative use for the major habitat types. Circular size plots of 1/300 acres (6.8 ft. radius) were located along linear transects.

Waterfowl

Information on waterfowl populations was derived from three sources. During fall 1974 through early spring 1975 aerial censuses of waterfowl were conducted from which estimates of wintering populations have been made. In the spring of 1974 and 1975 systematic searches for goose nests (except FDR reservoir) were made by the Washington Department of Game; A. W. Erickson, UW; and Battelle Northwest. These groups have made this information available for inclusion in this report. In addition to these more systematic counts records were kept of the occurrence of ducks and geese by members of the study team as they were working along the river. These observations along with the information from boat transects have been used to compile seasonal species lists for each river segment.

The aerial censuses were conducted during the hours 0930 to 1430 with approximately half of the study area being covered the first day and the remainder being covered the second day. Air speed was maintained at 65 to 80 mph depending on flying conditions.

Furbearers

Aquatic furbearers are defined to include beaver (*Castor canadensis*), muskrats (*Ondatra zibethicus*), nutria (*Myocastor coypus*), river otter (*Lutra canadensis*) and mink (*Mustela vison*). These mammals are grouped

to facilitate inventorying because all are normally associated with water and the immediate shoreline zone.

Shorelines were searched on foot, by boat, and in some cases by air for tracks, other "sign" (scat, trails, burrows, feeding areas, and territorial marking areas of beaver and otter), and direct observation of animals. The search was conducted primarily in late summer and fall because of normally low water levels and less frequent rainfall. Burrows of beaver, muskrat, and nutria, and tracks of animals traveling on or crossing the shoreline zone are easily observed under these conditions. Less intensive searches were also conducted during winter and spring seasons. During periods when a thin layer of soft snow covers shorelines, every effort was made to examine as much shoreline as possible.

Sampling of shorelines was stratified on the basis of broad classes of vegetation adjacent to the shoreline, land form class if there is no vegetation adjacent to the shoreline, and segment of the study area.

The number of furbearers harvested annually in counties in the study area and reported to the Washington Department of Game is available and was obtained for the 1973-74 and the 1974-75 trapping seasons (Table 8).

The methods outlined above for inventorying aquatic furbearers produced estimates of relative abundance of muskrat, mink, otter, and other mammals frequenting shoreline areas by habitat types and segment of the study area.

Terrestrial furbearers are defined to include opossums (Dedelphis marsupialis) and all native carnivores not mentioned above, such as long-tailed weasel (Mustela frenata), cougar and black bear.

To attract predators, we established three scent stations per transect, spaced 200 m apart. Each consisted of a wooden stake driven into the ground, with a 1-m radius of litter removed to expose the soil for track identification. A piece of sheepskin was nailed to the stake and saturated with a U.S. Fish and Wildlife Service predator scent.

Other birds

The techniques used for censusing birds varied with the structure and complexity of the habitat being sampled. An attempt to obtain as much uniformity as possible in both intensity and scope of coverage was made. Standard techniques or modification of these techniques were used

Table 8. Furbearer harvest along the left (L) and right (R) banks, by segment[a] of the upper Columbia River, for 1972-73, 1973-74, and 1974-75 (courtesy Washington Department of Game).

Segment	Beaver						Muskrat						Mink						Weasel						Badger					
	72-73		73-74		74-75		72-73		73-74		74-75		72-73		73-74		74-75		72-73		73-74		74-75		72-73		73-74		74-75	
	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Hanford	0	0	1	4[b]	8	0	0	19[b]	0	0	0	9[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Priest Rapids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wanapum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock Island	0	0	0	0	0	0	0	33	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocky Reach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1	0	0	0
Wanapum-Rocky Reach[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	13	0	2	0	0	0	11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rufus Woods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wanapum-Rufus Woods[a]	0	0	5	0	0	0	0	0	0	0	85	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells-Rufus Woods[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South FDR	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North FDR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	6	0	8	0	8	46	0	2	85	0	0	12	0	1	2	0	0	4	0	0	0	0	0	0	1	0	0	0

[a]Where the county harvest records indicated no specific location, animals trapped along the Columbia River could be located only within the segments (pools) combined within the county indicated.

[b]These probably are from the lower Columbia River, and therefore not included in the total. Most of the upper Columbia River in Benton County, from which these figures came, is in the inaccessible ERDA Hanford Reservation.

[c]These probably are from Wells pool since the right bank of Rufus Woods Lake is the Colville Indian Reservation which requires its own trapping license.

Table 8. Cont.

Segment	Raccoon						Coyote						Bobcat						Lynx					
	72-73		73-74		74-75		72-73		73-74		74-75		72-73		73-74		74-75		72-73		73-74		74-75	
	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Hanford	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1[b]	0	0	0	0	0	0
Priest Rapids	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Wanapum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
Rock Island	0	1	0	0	0	0	5	1	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Rocky Reach	0	3	0	0	0	11	2	4	18	0	0	5	0	0	0	2	0	0	0	0	0	0	0	0
Wanapum-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocky Reach[a]	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	3	3	0	0	0	0	1	0	1	0	0	0	0	0	6	0	0	0	0	0	0
Rufus Woods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wanapum-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rufus Woods[a]	5	0	6	0	10	0	21	0	0	0	45	0	2	0	0	0	1	0	0	0	0	0	0	0
Wells-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rufus Woods[a]	0	0	0	0	0	2[c]	0	0	0	3[c]	0	0	0	0	0	3[c]	0	4[c]	0	0	0	0	0	0
South FDR	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	1	0	0	0	1	0	0	0
North FDR	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
B.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	5	7	6	3	13	16	28	8	21	4	72	6	2	0	0	6	8	10	0	0	1	0	0	0

[a]Where the county harvest records indicated no specific location, animals trapped along the Columbia River could be located only within the segments (pools) combined within the county indicated.

[b]These probably are from the lower Columbia River, and therefore not included in the total. Most of the upper Columbia River in Benton County, from which these figures came, is in the inaccessible ERDA Hanford Reservation.

[c]These probably are from Wells pool since the right bank of Rufus Woods Lake is the Colville Indian Reservation which requires its own trapping license.

for all sampling schemes. The principal objectives of the sampling schemes were to provide information not only on the relative number of birds seen expressed as birds/hectare in different habitat types and different segments of the study area, but also information on habitat usage patterns, especially as they relate to the effects of the proposed river regulation. Finally, information on seasonal variation in species occurrence and abundance was sought.

The small passerines were censused on transects laid out parallel to the river in a variety of habitats encountered along the river with the objective of assessing the habitat utilization by the birds along the river. Counts were made during three seasons -- summer (May 17 - June 28), fall (Sept. 11 - Oct. 19), and winter (Jan. 15 - Feb. 19). A spring count was begun in March but at this time the spring migrants had not begun arriving on the study area and the census was discontinued. Timing of the other activities did not permit the rescheduling of the spring counts.

The census technique employed by the University of Washington study team involved walking down the center of the transect, recording the number and identity of birds observed. Birds outside of the habitat, or more than 55 yards (50 meters) on either side of the transect line were recorded as supplemental observations and were not included in the calculation of density. For the fall and winter seasons, all the habitats were treated in the same manner. During the summer census when the birds are more territorial and the males are singing a station technique was used on the transects with trees and/or shrubs where visibility is limited by the foliage. The station technique involved stopping at 100 m intervals along the transect for ten minutes and recording all birds heard or seen within that time interval. Counts were made on two consecutive days.

The transect census data was used in calculating bird densities and species diversity. The area of each transect covered by the census was based on a total width of 60 m or the width of the habitat strip which ever was smaller and the density was estimated using the total number of birds observed during the count. For the fall and winter, the average of the two day's counts was used while for the summer, the maximum number of individuals of each species was used as the value.

Species diversity was calculated from the census data using the diversity index; $D.I_{th} = \Sigma - pi/n_{pi}$, where $_{pi}$ is the proportion of the individuals in the i^{th} species.

Systematic counts of the less abundant larger birds (herons, hawks, game birds, etc.) were not made. Records were kept of observations of these birds by members of the study team and from these records species lists and information on the occurrence of these birds has been compiled.

Information on nest site selection was obtained for as many species as possible. Nesting data included type of vegetation in which it occurred, height from ground or water, placement within the area, nest contents, construction material, and distance from water's edge.

Small mammals

We obtained total counts of airborne bats within a specified area on the transect without species identification. Counts were made for 45 minutes during dusk. Samples for identification were taken by shotgun during the same period.

Included in the category of small mammals were shrews, mice, rats, weasels, moles, gophers, hares, rabbits, chipmunks, ground squirrels, tree squirrels, marmots, and porcupines.

Inventory of this group of mammals was primarily from trapping and observational transect counts conducted within the intensive sampling areas. Trapping was necessary for determining the presence of those species not easily observed and identified in field conditions.

Several methods of placing traps and several different types and sizes of traps were used to insure that all species are likely to be sampled. Some species of small mammals can normally be expected to be caught only in traps set in very specific ways. Because of this, the approach to be used in trapping was determined from existing literature and personal knowledge of individuals familiar with the mammalian fauna of the study area.

Trapping stations were spaced 33 meters apart (three per 100 meters) for 500 meters on every transect, or 15 trapping stations per transect. Each station received a baited and an unbaited museum special mouse trap, and at alternate stations a baited rat trap, a baited Sherman live trap, and an unbaited cone (pit) trap. Traps were located within a 5-meter radius of each station. Conibear, mole, and gopher traps were used as opportunities occurred.

On forested transects, every station also received one baited museum special nailed to a tree, or one baited Sherman live trap on a platform nailed to a tree with the trap door facing the tree. These tree traps were alternated in a ratio of two Sherman live traps to one museum special, so that each standard length transect of 15 stations had 15 baited and 15 unbaited museum specials, 5 rat, 5 Sherman live and 5 pit traps on the ground, and 5 baited museum specials and 10 Sherman live traps in trees. The bait was a mixture of beef suet, peanut butter, ground raisins, oatmeal, and paraffin (Taber and Cowan 1969:278). We kept baited and unbaited traps separate during transit to avoid scenting the unbaited museum specials. Specimens collected were taken to the University of Puget Sound where Dr. Murray Johnson, curator of mammals, verified identification.

Trapping was conducted for two or three consecutive days on each transect. In addition to transect sampling to document species occurrence, some trapping was conducted in microhabitats not occurring on transects.

The trapping methods described above for inventorying small mammals produced an index of abundance for each species by habitat type, segment of the study area, and season. The indices were in the form of captures per trap-night.

Reptiles and Amphibians

As with most of the mammals relative abundance and habitat preference was determined by comparing the percent of occupied transects. Numbers of observations also were compared.

Inventory of Human Use of Wildlife Resources

This inventory was conducted incidental to other phases of the study except that records of hunting, trapping and nonconsumptive use of wildlife resources (observations of animals, photography, etc.) was sought. Some information has been provided by cooperative agencies.

Assessment of Water Fluctuation

Areas of various fluctuating water levels were compared with respect to riparian habitat. Old aerial photos were examined for riparian habitat before flooding occurred in some areas, and compared to recent photos. Photo points were established to compare present and future conditions. The literature was examined concerning species tolerance to water fluctuations.

RESULTS AND DISCUSSION

Vegetation Types and Land Form Classes

Soils

No discussion of vegetation types and land form classes, particularly with respect to efforts of water fluctuation, would be complete without including information on soils. Since a detailed soil study was beyond the scope of this study, a general segment by segment description of the upper Columbia included mostly as presented by the State of Washington (1968) in their General Soil Map.

Soils along the Hanford segment tend to be moderately deep and deep, silt loam, loam, sandy loam, and sandy soils formed in wind-laid silts, glacial outwash, and alluvium..., with 15 to 20 cm annual precipitation (State of Washington 1968). The river runs between the Saddle Mountains and Rattlesnake Hills, which according to Hanson and Eberhardt (1971:7-8) ".... influence wind patterns so that they prevail from the northwest in the upper section [of the segment] and from the southwest in the lower

section. Soils of the region are classified as riverwash dune sand and sandy loam (Kocher and Strahorn 1919), much of which was deposited by glacial outwash at the southwest end of the channeled scablands to the north. These soils are highly susceptible to erosion by wind and water. Sheer sand and clay loam bluffs of the Ringold Formation rise some 70-100 m above the north bank for about 11 km in the upper section... Cemented gravel and clay bluffs of the Ringold Formation form the eastern border of the river in the lower part of the study area. Clay layers result in a danger of earth slippage through percolation of irrigation water used to the north (Wahluke Slope of the Columbia River Basin irrigation project). One such slippage of about 800,000 m^3 of earth recently occurred about 10 miles (15 km) west of the study area and another is imminent in the river bluffs of the lower section, near Island 13. Such events may change river channels and influence suitability of nearby islands as nesting habitat [for geese].

The arid climate and light soils of the region support a steppe vegetation association (Daubenmire 1970:5; Franklin and Dyrness 1969:143) dominated by big sagebrush and bunchgrass."

Soils along the Priest Rapids and Wanapum segments tend to be "shallow to deep, silt loam soils, many of which are stony or cobbly, formed in wind-laid silts and weathered basalt...," with 23 to 28 cm annual precipitation (State of Washington 1968).

The soil conditions described for the Priest Rapids and Wanapum segments apply to the Rock Island segment up to about RM 465. The rest of the segment generally consists of "moderately deep and deep, sandy loam soils formed in glacial outwash, alluvium, and lake sediments...," with 20 to 30 cm annual precipitation (State of Washington 1968).

Soil conditions described from RM 465 of the Rock Island segment apply to the Rocky Reach, Wells, and Rufus Woods Lake segments.

Along the right bank of South FDR from Grand Coulee Dam until about RM 614, soil conditions are as described for the Rock Island segment from RM 465. Along the left bank from Grand Coulee Dam until about RM 614, soils tend to be "very shallow to deep, silt loam and loam soils, many of which are gravelly or stony, formed in wind-laid silts, weathered basalt, and glacial outwash...," with 28 to 38 cm annual precipitation (State of Washington 1968). From about RM 614 and up the Spokane River, soils tend to be deep, silt loam, sandy, and sandy loam soils, some of which are gravelly or stony, formed in colluvium, alluvium, glacial outwash, and wind-laid silts...," with 30 to 41 cm annual precipitation (State of Washington 1968).

Soils in North FDR tend to be "deep, silt loam and sandy loam soils formed in lake sediments, wind-laid silts, volcanic ash, and alluvium...," with 36 to 46 cm annual precipitation (State of Washington 1968).

Soils along the left bank of the Northern Free-flowing Segment

tend to be as described for North FDR. Along the right bank soils tend to be "shallow to deep, mildly alkaline to strongly acid, sandy loam to silt loam soils formed in volcanic ash, underlain by glacial materials, andesite, basalt, argillite, limestone, granite, shale, and gneiss...," with 38 to 140 cm annual precipitation (State of Washington 1968).

Vegetation

The occurrence of major vegetation and vegetated land form types on each study segment was:

Study segment	No. of transects	Major vegetation types sampled
Hanford	2	Riparian shrub
	1	Equisetum
	1	Grassland (steppe)
	2	Cobble and shoreline gravel
	3	Shrub steppe
	1	Sand dune
Priest Rapids	2	Riparian shrub
	1	Shrub steppe
Wanapum	1	Riparian shrub
	2	Shrub steppe
	1	Sand dune
Rock Island	1	Riparian shrub
	2	Riparian tree
	1	Shrub steppe
Rocky Reach	3	Riparian shrub
	1	Cobble and shoreline gravel
	1	Shrub steppe
Wells	3	Riparian shrub
	1	Cobble and shoreline gravel
	1	Shrub steppe
Chief Joseph	2	Conifer
	4	Shrub steppe
South F.D.R.	3	Conifer
	3	Shrub steppe
North F.D.R.	1	Riparian tree

Study segment	No. of transects	Major vegetation types sampled
	1	Grassland (steppe)
	5	Conifer
Free-flowing North	4	Riparian tree
	1	Conifer
	1	Juniper

It was our intent to place transects in all major vegetation types, and on the whole this is what we did. At the same time, our study was oriented parallel to the river, and concentrated on vegetation types extensive enough to contain a 1000 meter transect. If a vegetation type occurred in small patches, it could not be sampled by transect. The main vegetation type of this sort we can call upland riparian shrub. It consisted of the dense shrubs, including *Crataegus*, which form streambottom thickets along small tributaries descending to the Columbia. This type, though studied, was not sampled by transect.

Of the approximately 810 shoreline miles, excluding islands and tributaries, along the upper Columbia River, about 88 miles (141 km) (11%) can be considered riparian (Table 9). There are 83 islands of measurable size in the upper Columbia River, of which 39 (47%) contain 116 acres (47 ha) (4%) of riparian growth, with the rest virtually devoid of riparian growth (Table 9). Superficially, the shoreline of the upper Columbia would seem to consist of few habitat types, most of which would be the shrub steppe characteristic of eastern Washington. In fact, the shrub steppe vegetation occurs along 139 miles (223 km) (29.6%) of the shoreline up to Grand Coulee Dam. From Grand Coulee Dam to the British Columbia border there is 100 shoreline miles (159 km) (29%) of conifers, and 175 shoreline miles (281 km) (51%) of sand, cliff, and slide areas, many of which border conifers. But, as Appendix A reveals, the habitat was diverse enough to complicate sampling and transect selection on islands and both banks.

The original riparian community has been flooded out along most of the river, and most of the islands, which are a valuable part of this complex, especially for goose nesting, are gone. Establishment of a new riparian zone is certainly a function of time, and probably of other factors such as loss of soil from the shore. The oldest impoundment, Rock Island, has

Table 9. Number and length[a] (km) of contiguous riparian habitat along the upper Columbia River, 1975.

Segment	Number of stretches of various length (km)											
									> 1.6			
	>0.2[b]	0.2	0.4	0.6	0.8	1.0	1.2	1.6	No.	Total length	Total length	Percent shoreline
Hanford	43	9	5	1	0	0	1	0	1	2.4	8.0	4.8
Priest Rapids	15	4	2	1	5	2	2	1	4	10.9	23.1	34.5
Wanapum	10	8	4	3	1	0	2	2	2	4.4	15.8	14.7
Rock Island	26	16	10	2	7	2	4	2	4	11.3	35.3	60.3
Rocky Reach	41	25	16	6	7	3	3	1	1	2.0	30.8	24.7
Wells	37	3	3	1	0	0	1	0	0	0.0	3.6	4.3
Rufus Woods	2	3	1	1	0	0	2	0	0	0.0	4.0	2.7
South FDR	5	0	0	0	0	0	0	0	0	0.0	0.0	0.0
North FDR	26	14	6	2	3	0	0	1	1	2.0	12.4	3.8
British Columbia	12	10	8	0	3	0	1	1	1	2.0	8.0	21.2
TOTAL	217	92	55	17	26	7	16	8	14	35.0	141.0	10.8

[a]Islands are not included.

[b]Not included in total length.

Table 10. Amount (ha) of riparian vegetation on the islands in the upper Columbia River.

Segment	Total islands	Islands with riparian No.	Islands with riparian Percent	Total area (ha)	Total riparian area No. ha	Total riparian area Percent
Hanford	17	9	52.9	548.42	5.58	1.02
Priest Rapids	6	4	67.7	30.00	6.40	21.33
Wanapum	5	3	60.0	170.00	10.20	6.00
Rock Island	12	10	83.3	12.88	9.48	73.60
Rocky Reach	6	6	100.0	69.40	4.80	6.92
Wells	11	5	45.5	294.00	2.80	0.95
Rufus Woods	1	0	0.0	12.20	0.00	0.00
South FDR	4	0	0.0	4.10	0.00	0.00
North FDR	14	0	0.0	47.80	0.00	0.00
British Columbia	7	2	28.6	22.60	7.80	34.51
TOTAL	83	39	47.0	1211.40	47.06	3.88

the best developed riparian habitat. Sixty percent of its shorelines are covered by riparian growth, and 74% of the island area (Table 9 and 10). Further studies probably could provide data from which to forecast the rate and composition of riparian development on new shorelines. Hanson and Eberhardt (1971:11) reported "willow clumps on several islands in the flowing section (of the Hanford area) tend to die out at an age of 16-26 years as measured by annual ring counts. Currant, often became associated with such clumps then also died out...willow flourished at the littoral zone on the upper edge of island 20, in the upper limit of the McNary Dam impoundment. This represents a successional condition owing the change from moving to slack water and elimination of scouring action of flood waters."

Presumably, there is no critical shortage of seed, and riparian development hinges on successful germination and establishment, which in turn are controlled by soil and moisture in large part. However, environmental factors along the Columbia might be adverse for seedling establishment in many areas, and artificial planting of shoots might be necessary on some sites.

It is obvious that soil type, influences from inland such as irrigation return, and current speed are all of potential significance in the development of riparian vegetation, and would have to be included in any study of riparian vegetation. Additional factors might include shoreline elevation, slope, and aspect, and wind speed and direction. Most of the older riparian vegetation is established in protected areas of low elevation and gentle slope. New growth spreads outward from the old growth, surrounding it, and eventually occupying some less protected areas. Our observations along the upper Columbia suggest some combination of low elevation and gentle slope, and stable soil conditions occurring on the exposed shoreline or unstable soil in areas protected from the erosive force of current, water fluctuation, and wave action, will produce riparian vegetation in quantity. In most areas, elevations of more than two feet above the shoreline (and, presumably, the water table) are void of riparian vegetation, regardless of other conditions. Stable water levels would enhance riparian development. Most soils along the upper Columbia are porous (and unstable) and will not hold the moisture needed for riparian growth.

Backwater areas, inlets, sloughs, bays and shoals exist in the upper Columbia, which if protected from erosion by diking, for example, could be encouraged to produce riparian stands, probably within a relatively short time if willow cuttings are planted.

The distribution of riparian habitats is strongly influenced by the environmental site factors previously discussed. Riparian habitats occurring within our study area are of two basic types: shrub and tree. Equisetum in many areas stands alone or is closely associated with riparian habitats. Therefore, equisetum may prove to be a reliable indicator of potential riparian sites.

Riparian species diversity typically increases from south to north along the river. A notable exception is Rock Island reservoir. This pool is the oldest in the upper Columbia River and has had the greatest period of time for riparian stands to develop. One transect in particular exhibits a great diversity of plant species. This transect is close to a large rail yard which allows for the introduction of species not native to the area. A past history of residential development also may have increased this plant diversity. Within this same reservoir a large stand of cottonwood has developed. Closely associated with this cottonwood stand is a peripheral stand of willows. The willows occur between the cottonwood and the river in a zone of periodic flooding. Silt deposits unaffected by frequent flooding and wave action appear to be the basis for the establishment of the cottonwood. Narrow strips of willow with a greater degree of other species in associations is the general pattern up to Lake Franklin D. Roosevelt.

The greatest degree of shoreline diversity occurs along the river in Lake FDR. In the southern portions of the lake where shorelines have been raised as much as 400 feet by water action and landslide activity (see Table 79), extensive riparian habitat does not occur. A number of factors account for this pattern. The southern portion of Lake FDR is well within the shrub steppe region of central Washington and is subject to drought conditions. Closely associated with this lack of moisture is the draw-down of the lake in winter and spring to accomodate spring runoff. This situation leaves established plants perched well above the water table for several early spring months. In the upper reaches of the lake, moisture is more abundant and established plants are not as subject to extended drought. Nevertheless, most riparian zones in Lake FDR are associated with small streams and spring areas. The major cottonwood stands occur in this northern area of Lake FDR, or beyond. These stands again are established on areas of silt accumulation that are subject to only infrequent flooding. Associated with these stands of cottonwood is an understory of birch, alder, red-osier dogwood, alder buckthorn, and lesser shrubs such as thimbleberry, poison ivy and rose. Such areas have had long periods in which to become established and are subject to relatively little disturbance by wave action and/or water fluctuation which has a seasonal pattern rather than a daily pattern in Lake FDR. The opportunity to establish further riparian zones around Lake FDR appear to be limited, restricted primarily to those areas that have an alternate source of water.

The establishment of riparian zones along the other pools in the upper Columbia has a consistent pattern if time since flooding and shoreline substrate are taken into account. In general those areas not subject to frequent disturbance by either water fluctuation or wave action support a vigorous growth of willows and associated forbs. However, Chief Joseph pool supports few willows, since soils are unstable and any disturbance by water action causes soil movement, hindering the germination and rooting of seed. In contrast, in backwater areas of Priest Rapids pool, dense stands of willow and Russian olive were created by State Department of Game planting programs. Such stands indicate that once established, the plants can flourish at least in semi-protected areas.

Before flooding, Wanapum pool supported narrow bands of willow along the flood plain, each band being associated with deposit of silts. This was typical of the river flood plain where stream bank gradients were not steep.

The scarcity of riparian zones along the reservoir margins indicates the lack of suitable areas for establishment plus the detrimental effects of water-caused disturbance upon the soil. Successful plantings have indicated that dense stands of shrubs can be created within the sheltered areas of backwaters and coves. The possibility for positive shoreline management to increase riparian habitat seems good.

Seventy-two transects were selected for sampling, of which 14 are boat and 58 are shoreline transects (see Table 1). Of the 58 shoreline transects, 20 involve riparian habitat, and 9 are on islands.

Transect names consisted of a trinomial if the transect contained a tree, shrub, and ground layer of vegetation, a binomial if any one of these was missing, or a monomial if any two were missing. The name of the tree and shrub with the greatest density was used, and the name of the herb, grasslike plant, or grass with the greatest ground cover was used. Preference was given to a perennial if its frequency exceeded 20 percent. Transects then were grouped according to their names.

A glance at the habitat diversity along the upper Columbia, revealed in Appendix 1, and the transect names in Tables 10 to 28, will indicate the difficulty of grouping transects. If the tree layers are the same, the shrub layers are not, and if the shrub layers are the same, the ground layers are not. Such was the general trend among almost all transects.

Nevertheless, because the number of transects already was small, we felt it necessary to group them in some fashion to increase sample size by group in order to facilitate data analysis. We felt there were enough general similarities in the transects to do this in most cases. The tendency was to group them according to layer, xeric condition, and land form. Habitats varied from narrow strips of willow 5 to 10 m wide to large expanses of sagebrush and ponderosa pine. Within those habitats represented by more than one transect, ranges in the derived values are large, indicating there is substantial variation within each habitat designation. All transect data analysis proceeded according to the following 9 general habitat types and the subgroups within them (Tables 10-28): boat (14), riparian shrub (12), equisetum (1), riparian tree (7), grassland (2), cobble and shoreline gravel (3), conifer (12), shrub steppe (19), sand dune (2). One of the sand dune transects is repeated in the shrub steppe habitat type.

Riparian shrub (Tables 11, 12, 13)

This community consisted of 10 willow transects, 1 dogwood transect, and 1 prickly rose transect. Transects were located in the Hanford, Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells segments. Typically, this habitat was found along the river bank within the low-high water zone, or within a very gradual slope of less than 1 m elevation above high water. Backwater areas created by pool flooding were lined in some cases by this vegetative community.

There were 12 species of grasses recorded, of which quackgrass, Reed canarygrass and Canada bluegrass occurred on 50% of the transects. Six (50%) of the grasses did not occur on other transects. Eight grasses occurred on the willow transects, and seven on the dogwood and rose transects. Reed canarygrass had the highest average frequency of occurrence (53%) on those transects where it occurred, but needle-and-thread had the most ground cover (0.60%). Three species of grasslike plants were recorded. Twenty-five species of forbs were recorded with only western scouringrush and cattail occurring on 50% of the transects. Eighteen (72%) of the forbs did not reoccur on other transects. Fourteen forbs occurred on the willow transects, and 15 on the dogwood and rose transects. Sagebrush (*Artemisia lindleyana*) had the highest frequency (45%) on those transects where it occurred, and western scouringrush had the most ground cover (58%).

Nineteen species of shrubs occurred, of which 13 species (68%) were macrophyllus, with coyote willow occurring on 92% of the transects, and peachleaf willow on 42%. The average crown cover of these two species was 18.9% and 28.4%, respectively, with an average frequency of occurrence of 38% and 58%, respectively, a density of 7307 and 1964 stems per ha, respectively, and an average height of 2.64 and 3.64 m, respectively. Only eight of the shrubs were abundant enough to occur in the sample.

Although the average frequency of occurrence for vegetation was 96% on these transects, and 86% for litter, the average basal cover was 2% for vegetation, 68% for litter, and 27% for bare ground.

Equisetum (Appendix E Transect 6)

Although pure stands of this habitat type are not extensive, the species itself is, at least in association with riparian communities. Thus, it was sampled as a stand, but with only one transect, and in the Hanford segment.

The community consisted of two species of grasses -- quackgrass and cheatgrass, cheatgrass having a frequency of occurrence of 50%. Five species of forbs occurred, western scouringrush having a frequency of 95%.

Table 11. Vegetation of the riparian shrub transects (11, 12, 21, 24, 29, 35, 36, 38, 69, 70, 71, 72) along the upper Columbia River.[d]

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Grasses									
Agropyron repens (Quackgrass)	25	5-50	0.30	0.02-0.67	-	-	-	-	50
Agropyron spicatum (Bluebunch wheatgrass)	5	-	0.40	-	-	-	-	-	13
Bromus tectorum (Cheatgrass brome)	37	15-65	0.43	0.15-0.65	-	-	-	-	38
Dactylis glomerata (Orchardgrass)	1	-	0.40	-	-	-	-	-	25
Festuca microstachys (Small fescue)	13	5-20	0.13	0.05-0.20	-	-	-	-	25
Koelaria cristata (Prairie junegrass)	-	-	-	-	-	-	-	-	13
Phalaris arundinacea (Reed canarygrass)	53	50-55	0.49	0.95-1.45	-	-	-	-	50
Poa compressa (Canada bluegrass)	30	20-40	0.27	0.17-0.37	-	-	-	-	50
Poa juncifolia (Alkali bluegrass)	5	-	0.05	-	-	-	-	-	13
Poa sandbergii (Sandberg bluegrass)	25	-	0.22	-	-	-	-	-	13
Stipa comata (Needle-and-thread)	15	-	0.60	-	-	-	-	-	13
Unknown	50	-	2.70	-	-	-	-	-	13
Grasslike plants									
Carex spp. (Sedge)	22	5-40	0.32	0.02-0.75	-	-	-	-	38
Juncus balticus (Baltic rush)	5	-	0.10	-	-	-	-	-	13
Scirpus acutus (Tule bulrush)	5	-	0.05	-	-	-	-	-	25
Forbs									
Achillea millefolium (Yarrow)	5	-	0.05	-	-	-	-	-	25
Agoseris spp. (Agoseris)	5	-	0.05	-	-	-	-	-	13
Artemisia lindleyana	45	-	0.45	-	-	-	-	-	13
Asparagus officinalis (Garden asparagus)	10	-	0.10	-	-	-	-	-	25
Aster spp. (Aster)	35	-	0.50	-	-	-	-	-	25
Balsamorhiza sagittata (Arrowleaf balsamroot)	5	-	0.05	-	-	-	-	-	13
Brassica spp. (Mustard)	5	-	0.10	-	-	-	-	-	13
Centaurea spp. (Centaurea, knapweed)	30	-	0.27	-	-	-	-	-	25
Cirsium arvense (Canada thistle)	5	-	0.05	-	-	-	-	-	13
Epilobium angustifolium (Fireweed)	35	-	0.35	-	-	-	-	-	13
Equisetum hymemale (Western scouringrush)	21	5-30	0.54	0.25-1.15	-	-	-	-	50
Filago arvensis	-	-	-	-	-	-	-	-	13
Lepidium perfoliatum (Clasping pepperweed)	-	-	-	-	-	-	-	-	13
Lupinus polyphyllus (Bigleaf lupine)	5	-	0.10	-	-	-	-	-	13
Lupinus spp. (Lupine)	-	-	-	-	-	-	-	-	13
Plantago patogonica (Indianwheat)	-	-	-	-	-	-	-	-	13
Rumex spp. (Dock, sorrel)	-	-	-	-	-	-	-	-	13

Table 11. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Forbs (cont.)									
Rumex venosus (Veiny dock)	25	-	0.25	-	-	-	-	-	13
Solanum dulcamara (Bitter nightshade)	15	-	0.12	-	-	-	-	-	13
Taraxacum officinale (Common dandelion)	-	-	-	-	-	-	-	-	13
Tragopogon dubius (Yellow salsify)	-	-	-	-	-	-	-	-	13
Typha latifolia (Common cattail)	15	-	0.15	-	-	-	-	-	50
Unknown	36	20-70	0.35	0.17-0.70	-	-	-	-	50
Urtica dioica (Big stinging nettle)	5	-	0.15	-	-	-	-	-	13
Verbascum thapsus (Flannel mullein)	-	-	-	-	-	-	-	-	13
Shrubs									
Alnus sinuata (Sitka alder, mountain alder)	-	-	-	-	108	-	4.27	-	8
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	-	-	-	-	8
Artemisia tridentata (Big sagebrush)	-	-	-	-	-	-	-	-	8
Artemisia tripartita (Threetip sagebrush)	-	-	-	-	-	-	-	-	8
Chrysothamnus nauseosus (Rubber rabbitbrush)	-	-	-	-	-	-	-	-	8
Chrysothamnus viscidiflorus (Tall rabbitbrush)	-	-	-	-	-	-	-	-	8
Cornus stolonifera (Red-osier dogwood)	-	-	-	-	323	-	0.85	-	8
Crataegus columbiana (Columbia hawthorn)	-	-	-	-	-	-	-	-	8
Eleagnus angustifolia (Russian olive)	100	-	50.00	-	646	108-1184	5.45	3.05-7.84	17
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	8
Morus rubra (Red mulberry)	15	5-25	11.85	2.80-20.90	108	-	2.29	1.52-3.05	17
Purshia tridentata (Antelope bitterbrush)	-	-	-	-	-	-	-	-	17
Rhus glabra (Smooth sumac)	-	-	-	-	-	-	-	-	8
Rhus radicans (Poison ivy)	-	-	-	-	-	-	-	-	8
Rosa acicularis (Prickly rose)	-	-	-	-	2152	968-3335	1.81	1.17-2.45	17
Rosa woodsii (Woods rose)	20	-	7.50	-	-	-	-	-	8
Salix amygdaloides (Peachleaf willow)	50	15-100	28.40	6.80-50.00	1964	108-6240	3.64	2.74-4.46	42
Salix exugua (Coyote willow)	38	10-85	18.94	1.75-31.30	7307	108-18,506	2.64	1.69-4.04	92
Salix spp. (Willow)	-	-	-	-	-	-	-	-	17
Trees									
Acer negundo (Boxelder)	25	-	27.10	-	-	-	-	-	8
Populus trichocarpa (Black cottonwood)	10	-	3.20	0.10-6.30	269	108-430	3.15	2.44-3.85	25

Table 11. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Vegetation	96	85-100	2.07	0.50-3.85					
Litter	86	0-100	67.86	3.60-99.50					
Rock	16	0-60	2.77	0.00-13.05					
Erosion pavement	0	-	0.00	-					
Bare ground	46	0-100	27.30	0.00-85.05					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

[c]Because transects 6, 9, 70, 71, and 72 were not sampled for grasses, grasslike plants, and forbs, they were omitted from calculation.

[d]Scientific nomenclature for all vegetation tables from: Asherin, D. A. 1973. Idaho Range-Plant Symbols Guide. University of Idaho, Info. Series No. 2. 91 pp.

Table 12. Vegetation of the willow transects (11, 12, 21, 35, 36, 38, 69, 70, 71, 72) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Grasses									
Agropyron repens (Quackgrass)	25	5-50	0.30	0.02-0.67	-	-	-	-	50
Bromus tectorum (Cheatgrass brome)	23	15-30	0.33	0.15-0.50	-	-	-	-	33
Dactylis glomerata (Orchardgrass)	1	-	0.40	-	-	-	-	-	33
Festuca microstachys (Small fescue)	13	5-20	0.13	0.05-0.20	-	-	-	-	33
Koelaria cristata (Prairie junegrass)	-	-	-	-	-	-	-	-	17
Phalaris arundinacea (Reed canarygrass)	50	-	0.97	-	-	-	-	-	50
Poa compressa (Canada bluegrass)	30	20-40	0.27	0.17-0.37	-	-	-	-	67
Unknown	50	-	2.70	-	-	-	-	-	17
Grasslike plants									
Carex spp. (Sedge)	22	5-40	0.32	0.02-0.75	-	-	-	-	50
Juncus balticus (Baltic rush)	5	-	0.10	-	-	-	-	-	17
Scirpus acutus (Tule bulrush)	5	-	0.05	-	-	-	-	-	33
Forbs									
Achillea millefolium (Yarrow)	-	-	-	-	-	-	-	-	17
Agoseris spp. (Agoseris)	5	-	0.05	-	-	-	-	-	17
Artemisia lindleyana	45	-	0.45	-	-	-	-	-	17
Asparagus officinalis (Garden asparagus)	-	-	-	-	-	-	-	-	17
Aster spp. (Aster)	-	-	-	-	-	-	-	-	17
Cirsium arvense (Canada thistle)	5	-	0.05	-	-	-	-	-	17
Equisetum hyemale (Western scouringrush)	20	5-30	0.58	0.25-1.15	-	-	-	-	50
Lupinus polyphyllus (Bigleaf lupine)	5	-	0.10	-	-	-	-	-	17
Plantago patogonica (Indianwheat)	-	-	-	-	-	-	-	-	17
Rumex spp. (Dock, sorrel)	-	-	-	-	-	-	-	-	17
Rumex venosus (Veiny dock)	25	-	0.25	-	-	-	-	-	17
Taraxacum officinale (Common dandelion)	-	-	-	-	-	-	-	-	17
Typha latifolia (Common cattail)	15	-	0.15	-	-	-	-	-	67
Unknown	36	20-70	0.35	0.17-0.70	-	-	-	-	67

Table 12. Cont.

Species[a]	Percent frequency Mean	Percent frequency Range	Percent ground cover[b] Mean	Percent ground cover[b] Range	Shrubs & Trees per ha Mean	Shrubs & Trees per ha Range	Shrub & Tree height (m) Mean	Shrub & Tree height (m) Range	Transects occupied (%)[c]
Shrubs									
Eleagnus angustifolia (Russian olive)	100	-	50.00	-	1184	-	7.84	-	10
Morus rubra (Red mulberry)	5	-	2.80	-	-	-	-	-	10
Purshia tridentata (Antelope bitterbrush)	-	-	-	-	-	-	-	-	10
Rosa acicularis (Prickly rose)	-	-	-	-	-	-	-	-	10
Salix amygdaloides (Peachleaf willow)	58	15-100	28.40	6.80-50.00	1964	108-6240	3.64	2.74-4.46	50
Salix exigua (Coyote willow)	42	10-85	16.47	1.75-27.70	8823	323-18,506	2.58	1.69-3.66	90
Salix spp. (Willow)	-	-	-	-	-	-	-	-	20
Trees									
Populus trichocarpa (Black cottonwood)	10	-	0.10	-	108	-	2.44	-	20
Vegetation	98	85-100	2.00	0.50-3.85					
Litter	82	0-100	65.47	3.60-99.50					
Rock	13	0-60	1.52	0.00-8.60					
Erosion pavement	0	-	0.00	0					
Bare ground	45	0-100	31.02	0.00-85.05					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

[c]Because transects 69, 70, 71, and 72 were not sampled for grasses, grasslike plants, and forbs, they were omitted from calculation.

Table 13. Vegetation of the rose and dogwood transects (24, 29) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	-	-	-	-	-	-	-	-	50
Agropyron spicatum (Bluebunch wheatgrass)	5	-	0.40	-	-	-	-	-	50
Bromus tectorum (Cheatgrass brome)	65	-	0.65	-	-	-	-	-	50
Phalaris arundinacea (Reed canarygrass)	55	-	1.45	-	-	-	-	-	50
Poa juncifolia (Alkali bluegrass)	5	-	0.05	-	-	-	-	-	50
Poa sandbergii (Sandberg bluegrass)	25	-	0.22	-	-	-	-	-	50
Stipa comata (Needle-and-thread)	15	-	0.60	-	-	-	-	-	50
Forbs									
Achillea millefolium (Yarrow)	5	-	0.05	-	-	-	-	-	50
Asparagus officinalis (Garden asparagus)	10	-	0.10	-	-	-	-	-	50
Aster spp. (Aster)	35	-	0.50	-	-	-	-	-	50
Balsamorhiza sagittata (Arrowleaf balsamroot)	5	-	0.05	-	-	-	-	-	50
Brassica spp. (Mustard)	5	-	0.10	-	-	-	-	-	50
Centaurea spp. (Centaurea, knapweed)	30	-	0.27	-	-	-	-	-	100
Epilobium angustifolium (Fireweed)	35	-	0.35	-	-	-	-	-	50
Equisetum hymemale (Western scouringrush)	25	-	0.40	-	-	-	-	-	50
Filago arvensis	-	-	-	-	-	-	-	-	50
Lepidium perfoliatum (Clasping pepperweed)	-	-	-	-	-	-	-	-	50
Lupinus spp. (Lupine)	-	-	-	-	-	-	-	-	50
Solanum dulcamara (Bitter nightshade)	15	-	0.12	-	-	-	-	-	50
Tragopogon dubius (Yellow salsify)	-	-	-	-	-	-	-	-	50
Urtica dioica (Big stinging nettle)	5	-	0.15	-	-	-	-	-	50
Verbascum thapsus (Flannel mullein)	-	-	-	-	-	-	-	-	50

Table 13. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Shrubs									
Alnus sinuata (Sitka alder, mountain alder)	-	-	-	-	108	-	4.27	-	50
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	-	-	-	-	50
Artemisia tridentata (Big sagebrush)	-	-	-	-	-	-	-	-	50
Artemisia tripartita (Threetip sagebrush)	-	-	-	-	-	-	-	-	50
Chrysothamnus nauseosus (Rubber rabbitbrush)	-	-	-	-	-	-	-	-	50
Chrysothamnus viscidiflorus (Tall rabbitbrush)	-	-	-	-	-	-	-	-	50
Cornus stolonifera (Red-osier dogwood)	-	-	-	-	323	-	0.85	-	50
Crataegus columbiana (Columbia hawthorn)	-	-	-	-	-	-	-	-	50
Eleagnus angustifolia (Russian olive)	-	-	-	-	108	-	3.05	-	50
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	50
Morus rubra (Red mulberry)	25	-	20.90	-	108	-	2.29	1.52-3.05	100
Purshia tridentata (Antelope bitterbrush)	-	-	-	-	-	-	-	-	50
Rhus glabra (Smooth sumac)	-	-	-	-	-	-	-	-	50
Rhus radicans (Poison ivy)	-	-	-	-	-	-	-	-	50
Rosa acicularis (Prickly rose)	-	-	-	-	968	-	1.17	-	50
Rosa woodsii (Woods rose)	20	-	7.50	-	-	-	-	-	50
Salix exigua (Coyote willow)	20	-	31.30	-	485	108-861	2.94	1.83-4.04	100
Trees									
Acer negundo (Boxelder)	25	-	27.10	-	-	-	-	-	50
Populus trichocarpa (Black cottonwood)	10	-	6.30	-	430	-	3.85	-	50
Vegetation	93	85-100	2.30	1.90-2.70					
Litter	100	-	75.03	52.90-97.15					
Rock	23	0-45	6.53	0.00-13.05					
Erosion pavement	0	-	0.00	-					
Bare ground	48	5-90	16.15	0.15-32.15					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Both live vegetation and litter occurred with a frequency of 100%, but the basal coverage was 1% for vegetation, 95% for litter, and 4% for bare ground.

Riparian tree (Tables 14, 15, 16)

To some extent this category includes two birch and five cottonwood transects. Except for two cottonwood transects, all transects occurred north of Kettle Falls (within 40 river miles of the British Columbia border). Transects occurred in the Rock Island, North FDR and British Columbia segments.

Seven species of grasses were recorded, of which quackgrass occurred on 71% of the seven transects. Its frequency of occurrence on these transects was 53%, with 0.65% ground cover. All seven grasses occurred on the cottonwood transects, and three of the grasses occurred on the birch transects. No grasslike plants were recorded.

Nineteen species of forbs were recorded, of which 11 occurred on the two birch transects, and 11 on the five cottonwood transects. Garden asparagus and western scouringrush occurred most often (43%), with the latter having 28% frequency of occurrence on the occupied transects.

Twenty-three species of shrubs were identified, all of which were macrophyllus. Eighteen species of shrub occurred on the two birch transects, and 17 on the five cottonwood transects. Columbia hawthorn and common snowberry appeared most often (on 71% of the transects), with the latter species having a frequency of occurrence of 32% on the occupied transects.

Eight species of trees occurred, of which seven were on the two birch transects, and three on the five cottonwood transects. Four species of conifer occurred on the birch transects. The three cottonwood transects of the British Columbia segment contained mature cottonwood of 20-30 cm dbh. The average height of the cottonwoods and birch sampled was 9.8 m and 10.7 m, with a density of 1313 and 700 stems per ha, and a crown cover of 50% and 68%, respectively. Aspen occurred on two of the cottonwood transects in a density of 699 stems per ha and a mean height of 7.7 m.

The basal coverage was 1% for live vegetation, 84% for litter and 14% for bare ground. The cottonwood Transect 64 was heavily grazed by cattle (see Appendix 4).

Grassland (Table 17)

As with the Equisetum community, grassland communities (without trees or shrubs) were not extensive. Two transects were established -- one on an island in the Hanford segment and one along North FDR, but only the Hanford transect was sampled for vegetation. The North FDR transect borders a backwater channel and is subject to periodic

Table 14. Vegetation of the riparian tree transects (25, 27, 60, 63, 64, 65, 66) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	53	5-85	0.65	0.05-1.57	-	-	-	-	71
Agrostis alba (Redtop)	30	15-46	0.26	0.10-0.42	-	-	-	-	29
Bromus tectorum (Cheatgrass brome)	5	-	0.02	-	-	-	-	-	29
Elymus glaucus (Blue wildrye)	-	-	-	-	-	-	-	-	14
Phleum pratense (Timothy)	50	-	0.47	-	-	-	-	-	14
Poa compressa (Canada bluegrass)	33	15-55	0.51	0.22-0.55	-	-	-	-	43
Poa juncifolia (Alkali bluegrass)	5	-	0.40	-	-	-	-	-	14
Forbs									
Achillea millefolium (Yarrow)	45	-	0.35	-	-	-	-	-	29
Asclepias speciosa (Showy milkweed)	-	-	-	-	-	-	-	-	29
Asparagus officinalis (Garden asparagus)	10	-	0.07	-	-	-	-	-	43
Brassica spp. (Mustard)	-	-	-	-	-	-	-	-	29
Campanula rotundifolia (American bellflower)	-	-	-	-	-	-	-	-	14
Centaurea spp. (Centaurea, knapweed)	-	-	-	-	-	-	-	-	14
Disporum trachycarpum (Wartberry fairy bells)	-	-	-	-	-	-	-	-	14
Equisetum hyemale (Western scouringrush)	28	5-50	0.19	0.02-0.35	-	-	-	-	43
Fragaria vesca (Woods strawberry)	45	-	0.42	-	-	-	-	-	14
Galium boreale (Northern bedstraw)	-	-	-	-	-	-	-	-	29
Lupinus spp. (Lupine)	-	-	-	-	-	-	-	-	14
Prunella vulgaris (Common selfheal)	5	-	0.02	-	-	-	-	-	14
Smilacina stellata (Starry solomonplume)	5	-	0.05	-	-	-	-	-	29
Solanum dulcamera (Bitter nightshade)	-	-	-	-	-	-	-	-	29
Taraxicum officinale (Common dandelion)	23	15-30	0.19	0.15-0.22	-	-	-	-	29
Unknown	13	5-20	0.11	0.05-0.17	-	-	-	-	43
Urtica dioica (Big stinging nettle)	15	-	0.15	-	-	-	-	-	14
Verbascum thapsus (Flannel mullein)	-	-	-	-	-	-	-	-	14
Vicia americana (American vetch)	5	-	0.05	-	-	-	-	-	29

Table 14. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Shrubs									
Acer glabrum (Rocky mountain maple)	30	-	42.90	-	-	-	-	-	29
Alnus sinuata (Sitka alder, mountain alder)	10	-	4.10	-	269	108-430	4.50	4.27-4.72	43
Amelanchier alnifolia (Saskatoon serviceberry)	18	5-30	6.85	2.70-11.00	-	-	-	-	29
Berberis repens (Low oregongrape)	38	20-55	8.10	3.60-12.60	3120	-	0.19	-	29
Ceanothus sanguineus (Redstem ceanothus)	-	-	-	-	-	-	-	-	41
Cornus stolonifera (Red-osier dogwood)	13	10-15	7.47	2.20-13.70	618	215-1076	3.35	2.74-3.91	57
Corylus cornuta	50	44-55	26.70	23.10-30.30	323	-	1.73	-	43
Crataegus columbiana (Columbia hawthorn)	20	15-25	9.59	4.90-15.10	216	108-323	3.36	0.61-6.10	71
Crataegus douglasii (Black hawthorn)	-	-	-	-	753	-	3.47	-	14
Holodiscus discolor (Creambush oceanspray)	15	-	7.50	-	646	-	3.86	-	14
Pachistima myrsinites (Pachistima, Mt. lover)	-	-	-	-	646	-	0.20	-	14
Philadelphus lewisii (Mockorange)	20	-	14.00	-	377	323-430	3.02	2.84-3.20	29
Prunus virginiana (Common chokecherry)	-	-	-	-	108	-	0.61	-	29
Rhamnus alnifolia (Alder buckthorn)	25	5-45	15.45	4.00-26.90	1506	430-3658	3.76	1.84-5.49	43
Rhus radicans (Poison ivy)	10	-	4.40	-	-	-	-	-	57
Rosa gymnocarpa (Baldhip rose)	5	-	0.10	-	-	-	-	-	14
Rosa woodsii (Woods rose)	23	20-25	12.60	4.70-20.50	-	-	-	-	57
Rubus parviflorus (Thimbleberry)	40	-	28.20	-	-	-	-	-	14
Salix amygdaloides (Peachleaf willow)	-	-	-	-	-	-	-	-	29
Salix exigua (Coyote willow)	10	-	5.80	-	-	-	-	-	14
Salix spp. (Willow)	-	-	-	-	-	-	-	-	14
Spiraea douglasii (Douglas spirea)	10	-	1.20	-	4519	430-8607	0.34	0.25-0.42	29
Symphoricarpos albus (Common snowberry)	32	5-60	12.10	1.20-20.60	2609	1076-5164	0.77	0.54-1.14	71
Trees									
Betula occidentalis (Water birch)	-	-	-	-	-	-	-	-	29
Betula papyrifera (Paper birch)	60	55-65	67.65	57.20-78.10	700	538-861	10.73	9.26-12.19	29
Larix occidentalis (Western larch)	25	-	19.10	-	-	-	-	-	14
Pinus ponderosa (Ponderosa pine)	25	20-30	22.50	15.00-30.00	-	-	-	-	29
Populus tremuloides (Quaking aspen)	-	-	-	-	699	430-968	7.65	1.57-13.72	29
Populus trichocarpa (Black cottonwood)	61	20-95	50.04	12.00-83.00	1313	108-3873	9.81	1.34-17.42	86
Psuedotsuga menziesii (Douglas-fir)	-	-	-	-	430	-	11.20	-	14
Thuja plicata (Western redcedar)	-	-	-	-	108	-	0.20	-	14

Table 14. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Vegetation	70	30-100	1.41	0.80-2.73					
Litter	97	90-100	84.13	34.65-99.20					
Rock	3	0-15	0.14	0.00-0.50					
Erosion pavement	0	-	0.00	-					
Bare ground	26	0-90	14.33	0.00-64.20					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 15. Vegetation of the cottonwood transects (25, 27, 63, 64, 65) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	53	5-85	0.65	0.05-1.57	-	-	-	-	80
Agrostis alba (Redtop)	30	15-45	0.26	0.10-0.42	-	-	-	-	40
Bromus tectorum (Cheatgrass brome)	5	-	0.02	-	-	-	-	-	20
Elymus glaucus (Blue wildrye)	-	-	-	-	-	-	-	-	20
Phleum pratense (Timothy)	50	-	0.47	-	-	-	-	-	20
Poa compressa (Canada bluegrass)	43	30-55	0.50	0.22-0.77	-	-	-	-	40
Poa juncifolia (Alkali bluegrass)	5	-	0.40	-	-	-	-	-	20
Forbs									
Achillea millefolium (Yarrow)	45	-	0.35	-	-	-	-	-	20
Asclepias speciosa (Showy milkweed)	-	-	-	-	-	-	-	-	20
Asparagus officinalis (Garden asparagus)	10	-	0.07	-	-	-	-	-	40
Brassica spp. (Mustard)	-	-	-	-	-	-	-	-	20
Equisetum hyemale (Western scouringrush)	28	5-50	0.19	0.02-0.35	-	-	-	-	60
Fragaria vesca (Woods strawberry)	45	-	0.42	-	-	-	-	-	20
Galium boreale (Northern bedstraw)	-	-	-	-	-	-	-	-	20
Prunella vulgaris (Common selfheal)	5	-	0.02	-	-	-	-	-	20
Smilacina stellata (Starry solomonplume)	-	-	-	-	-	-	-	-	20
Taraxicum officinale (Common dandelion)	23	15-30	0.19	0.15-0.22	-	-	-	-	40
Unknown	13	5-20	0.11	0.05-0.17	-	-	-	-	60
Shrubs									
Alnus sinuata (Sitka alder, mountain alder)	10	-	4.10	-	-	-	-	-	20
Amelanchier alnifolia (Saskatoon serviceberry)	30	-	11.00	-	-	-	-	-	20
Berberis repens (Low oregongrape)	20	-	3.60	-	-	-	-	-	20
Ceanothus sanguineus (Redstem ceanothus)	-	-	-	-	-	-	-	-	20
Cornus stolonifera (Red-osier dogwood)	13	10-15	7.47	2.20-13.70	646	215-1076	3.55	3.35-3.91	60
Corylus cornuta	-	-	-	-	-	-	-	-	20
Crataegus columbiana (Columbia hawthorn)	20	15-25	9.59	4.90-15.10	216	108-323	3.36	0.61-6.10	80
Crataegus douglasii (Black hawthorn)	-	-	-	-	753	-	3.47	-	20
Prunus virginiana (Common chokecherry)	-	-	-	-	108	-	0.61	-	20
Rhamnus alnifolia (Alder buckthorn)	45	-	26.90	-	3658	-	1.84	-	20

Table 15. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Shrubs (cont.)									
Rhus radicans (Poison ivy)	-	-	-	-	-	-	-	-	40
Rosa woodsii (Woods rose)	20	-	4.70	-	-	-	-	-	60
Salix amygdaloides (Peachleaf willow)	-	-	-	-	-	-	-	-	20
Salix exigua (Coyote willow)	10	-	5.80	-	-	-	-	-	20
Salix spp. (Willow)	-	-	-	-	-	-	-	-	20
Spiraea douglasii (Douglas spirea)	10	-	1.20	-	4519	430-8607	0.34	0.25-0.42	40
Symphoricarpos albus (Common snowberry)	33	5-60	10.90	1.20-20.60	1345	1076-1614	0.60	0.54-0.66	60
Trees									
Pinus ponderosa (Ponderosa pine)	20	-	15.00	-	-	-	-	-	20
Populus tremuloides (Quaking aspen)	-	-	-	-	699	430-968	7.65	1.57-13.72	40
Populus trichocarpa (Black cottonwood)	61	20-95	50.04	12.00-83.00	1614	646-3873	8.46	1.34-17.42	100
Vegetation	83	65-100	1.59	0.85-2.73					
Litter	98	95-100	81.16	34.65-89.90					
Rock	4	0-15	0.19	0.00-0.50					
Erosion pavement	0	-	0.00	-					
Bare ground	31	20-90	17.06	9.73-64.20					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 16. Vegetation of the birch transects (60, 66) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	-	-	-	-	-	-	-	-	50
Bromus tectorum (Cheatgrass brome)	-	-	-	-	-	-	-	-	50
Poa compressa (Canada bluegrass)	15	-	0.55	-	-	-	-	-	50
Forbs									
Asparagus officinalis (Garden asparagus)	-	-	-	-	-	-	-	-	50
Campanula rotundifolia (American bellflower)	-	-	-	-	-	-	-	-	50
Centaurea spp. (Centaurea, knapweed)	-	-	-	-	-	-	-	-	50
Diosporum trachycarpum (Wartberry fairybells)	-	-	-	-	-	-	-	-	50
Galium boreale (Northern bedstraw)	-	-	-	-	-	-	-	-	50
Lupinus spp. (Lupine)	-	-	-	-	-	-	-	-	50
Smilacina stellata (Starry solomonplume)	5	-	0.05	-	-	-	-	-	50
Solonum dulcamera (Bitter nightshade)	-	-	-	-	-	-	-	-	100
Urtica dioica (Big stinging nettle)	15	-	0.15	-	-	-	-	-	50
Verbascum thapsus (Flannel mullein)	-	-	-	-	-	-	-	-	50
Vicia americana (American vetch)	5	-	0.05	-	-	-	-	-	100
Shrubs									
Acer glabrum (Rocky mountain maple)	30	-	42.90	-	-	-	-	-	100
Alnus sinuata (Sitka alder, mountain alder)	-	-	-	-	269	108-430	4.50	4.27-4.72	100
Amelanchier alnifolia (Saskatoon serviceberry)	5	-	2.70	-	-	-	-	-	50
Berberis repens (Low oregongrape)	55	-	12.60	-	3120	-	0.19	-	50
Cornus stolifera (Red-osier dogwood)	-	-	-	-	538	-	2.74	-	50
Corylus cornuta	50	45-55	26.70	23.10-30.30	323	-	1.73	-	100
Crataegus columbiana (Columbia hawthorn)	-	-	-	-	-	-	-	-	50
Holodiscus discolor (Creambush oceanspray)	15	-	7.50	-	646	-	3.86	-	50
Phacistima myrsinites (Pachistima, Mt. lover)	-	-	-	-	646	-	0.20	-	50
Philadelphus lewisii (Mockorange)	20	-	14.00	-	377	323-430	3.02	2.84-3.20	100
Prunus virginiana (Common chokecherry)	-	-	-	-	-	-	-	-	50
Rhamnus alnifolia (Alder buckthorn)	5	-	4.00	-	430	-	4.73	3.96-5.49	100
Rhus radicans (Poison ivy)	10	-	4.40	-	-	-	-	-	100
Rosa gymnocarpa (Baldhip rose)	5	-	0.10	-	-	-	-	-	50
Rosa woodsii (Woods rose)	25	-	20.50	-	-	-	-	-	50
Rubus parviflorus (Thimbleberry)	40	-	28.20	-	-	-	-	-	50
Salix amygdaloides (Peachleaf willow)	-	-	-	-	-	-	-	-	50
Symphoricarpos albus (Common snowberry)	30	-	14.50	-	3873	2582-5164	0.94	0.73-1.14	100

Table 16. Cont.

Species[a]	Percent frequency Mean	Percent frequency Range	Percent ground cover[b] Mean	Percent ground cover[b] Range	Shrubs & Trees per ha Mean	Shrubs & Trees per ha Range	Shrub & Tree height (m) Mean	Shrub & Tree height (m) Range	Transects occupied (%)
Trees									
Betula occidentalis (Water birch)	-	-	-	-	-	-	-	-	100
Betula papyrifera (Paper birch)	60	55-65	67.65	57.20-78.10	700	538-861	10.73	9.26-12.19	100
Larix occidentalis (Western larch)	25	-	19.10	-	-	-	-	-	50
Pinus ponderosa (Ponderosa pine)	30	-	30.00	-	-	-	-	-	50
Populus trichocarpa (Black cottonwood)	-	-	-	-	108	-	15.24	-	50
Psuedotsuga menziesii (Douglas-fir)	-	-	-	-	430	-	11.20	-	50
Thuja plicata (Western redcedar)	-	-	-	-	108	-	0.20	-	50
Vegetation	38	30-45	0.95	0.80-1.10					
Litter	95	90-100	91.55	83.90-99.20					
Rock	0	-	0.00	-					
Erosion pavement	0	-	0.00	-					
Bare ground	13	0-25	7.50	0.00-15.00					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 17. Vegetation of the grassland transects (8, 68) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Grasses									
Agropyron repens (Quackgrass)	20	-	0.20	-	-	-	-	-	100
Bromus tectorum (Cheatgrass brome)	55	-	0.55	-	-	-	-	-	100
Elymus cinereus (Giant wildrye)	55	-	21.85	-	-	-	-	-	100
Phalaris arundinacea (Reed canarygrass)	-	-	-	-	-	-	-	-	-
Stipa comata (Needle-and-thread)	-	-	-	-	-	-	-	-	100
Forbs									
Achillea millefolium (Yarrow)	30	-	0.30	-	-	-	-	-	100
Brassica spp. (Mustard)	-	-	-	-	-	-	-	-	100
Centaurium spp. (Centaurium)	-	-	-	-	-	-	-	-	100
Cerastium arvense (Starry cerastium)	5	-	0.05	-	-	-	-	-	100
Cryptogramma spp. (Rockbrake)	5	-	0.05	-	-	-	-	-	100
Equisetum hyemale (Western scouringrush)	10	-	0.15	-	-	-	-	-	100
Lepidium perfoliatum (Clasping pepperweed)	55	-	0.55	-	-	-	-	-	100
Lupinus spp. (Lupine)	-	-	-	-	-	-	-	-	100
Vegetation	80	-	22.45	-					
Litter	90	-	68.60	-					
Rock	0	-	0.00	-					
Erosion pavement	0	-	0.00	-					
Bare ground	40	-	8.95	-					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

[c]Because transect 68 was not sampled for grasses, grasslike plants, and forbs, it was omitted from calculation.

flooding. Consequently, the vegetative composition of the two differ substantially from this aspect, as well as from the latitude and soil differences.

The North FDR transect is covered almost entirely by reed canarygrass. The Hanford transect consists of four species of grasses, of which giant wildrye dominates, with a frequency of 55%, and 22% ground cover. The Hanford transect also had eight species of forbs recorded, of which clasping pepperweed dominated, with a frequency of 55%, with 0.55% ground cover.

On the Hanford transect, live vegetation had a frequency of 80%, litter 90%, and bare ground 40%. The basal coverage was 22% for live vegetation, 69% for litter, and 9% for bare ground.

Cobble and shoreline gravel (Tables 18, 19, Appendix E Transect 40)

Three cobble areas, subject to annual inundation during spring high water, were chosen for sampling. Two of these were in the Hanford segment, and one was in Rocky Reach. The latter was not sampled for ground cover. The dominant feature of these three transects was the presence of rock, exposed from erosion. Rock sizes varied from small pea-size gravel to large rock and boulders up to 1 m in diameter. The shoreline gravel habitat type was associated exclusively with old stream terraces deposited during Pleistocene floods. Steep banks of undifferentiated gravels, up to 15 m high, are characteristic. Fine gravels and soil occurring within the tidal zone of the river have been removed, leaving an assortment of loose rock and boulders. One transect was placed in this habitat type in the Wells segment. Vegetation varied on these transects, but they were grouped because their land form class was similar.

On the two Hanford transects and the Wells transect, seven species of grasses occurred, of which five did not reoccur on more than one transect. Cheatgrass brome occurred on all transects, in an average frequency of 28%, with 38% ground cover on the cobble transects. It was not abundant enough to fall within the sampling frame on the shoreline gravel transect. Five species of grass occurred on the two cobble transects, and four on the shoreline gravel.

Altogether, 17 species of forbs were recorded, of which 12 were on the cobble and five on the shoreline gravel transects. No species of forb occurred on more than one of these three transects.

Eleven species of shrub occurred on the three cobble and one shoreline gravel transect combined, four of which were on the cobble transects, and seven of which were on the shoreline gravel transect. As with the forbs, no species of shrub occurred on more than one transect. The dominant shrub on the shoreline gravel transect was chokecherry with a density of 4626 stems per ha, averaging 1.1 m tall.

Table 18. Vegetation of the cobble and shoreline gravel transects (2, 9, 33, 40) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Grasses									
Agropyron repens (Quackgrass)	-	-	-	-	-	-	-	-	33
Agropyron spicatum (Bluebunch wheatgrass)	-	-	-	-	-	-	-	-	33
Bromus tectorum (Cheatgrass brome)	28	5-50	37.50	0.05-0.70	-	-	-	-	100
Elymus cinereus (Giant wildrye)	-	-	-	-	-	-	-	-	33
Festuca microstachys (Small fescue)	30	-	0.30	-	-	-	-	-	33
Oryzopsis hymenoides (Indian ricegrass)	-	-	-	-	-	-	-	-	33
Stipa comata (Needle-and-thread)	-	-	-	-	-	-	-	-	67
Forbs									
Achillea millefolium (Yarrow)	50	-	1.00	-	-	-	-	-	33
Brassica spp. (Mustard)	85	-	1.45	-	-	-	-	-	33
Brodiaea douglasii (Douglas brodiea)	-	-	-	-	-	-	-	-	33
Clematis ligusticifolia (Western virginsbower)	-	-	-	-	-	-	-	-	33
Cymopterus terebinthinus	-	-	-	-	-	-	-	-	33
Erigeron compositus (Dwarf mountain fleabane)	5	-	0.10	-	-	-	-	-	33
Eriogonum compositum (Northern buckwheat)	15	-	0.20	-	-	-	-	-	33
Lomatium dissectum (Carrotleaf leptotaenia)	10	-	0.10	-	-	-	-	-	33
Lupinus spp. (Lupine)	30	-	0.35	-	-	-	-	-	33
Mentha spp. (Mint)	-	-	-	-	-	-	-	-	33
Oenothera pallida (Pale eveningprimrose)	-	-	-	-	-	-	-	-	33
Plantago patogonica (Indianwheat)	-	-	-	-	-	-	-	-	33
Rumex venosus (Veiny dock)	-	-	-	-	-	-	-	-	33
Salsola kali tenuifolia (Russianthistle)	-	-	-	-	-	-	-	-	33
Scutellaria angustifolia (Narrowleaf skullcap)	-	-	-	-	-	-	-	-	33
Tragopogon dubius (Yellow salsify)	-	-	-	-	-	-	-	-	33
Unknown	15	-	0.15	-	-	-	-	-	33
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	323	-	1.83	-	25
Artemisia tridentata (Big sagebrush)	-	-	-	-	108	-	0.61	-	25
Artemisia tripartita (Threetip sagebrush)	-	-	-	-	-	-	-	-	25
Chrysothamnus nauseosus (Rubber rabbitbrush)	-	-	-	-	-	-	-	-	25
Chrysothamnus viscidiflorus (Tall green rabbitbrush)	-	-	-	-	-	-	-	-	25

Table 18. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Shrubs (cont.)									
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	25
Prunus virginiana (Common chokecherry)	10	-	2.90	-	4626	-	1.11	-	25
Purshia tridentata (Antelope bitterbrush)	15	-	13.40	-	-	-	-	-	25
Rhus radicans (Poison ivy)	-	-	-	-	-	-	-	-	25
Rosa acicularis (Prickly rose)	-	-	-	-	-	-	-	-	25
Salvia dorri (Purple sage)	-	-	-	-	323	-	0.37	-	25
Trees									
Juniperus occidentalis (Western juniper)	-	-	-	-	108	-	0.61	-	25
Vegetation	83	65-100	2.08	0.80-3.35					
Litter	65	15-100	15.63	1.15-42.50					
Rock	82	45-100	71.35	19.35-97.95					
Erosion pavement	0	-	0.00	-					
Bare ground	27	0-75	11.63	0.00-34.80					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

[c]Because transect 33 was not sampled for grasses, grasslike plants, and forbs, it was omitted from calculation.

Table 19. Vegetation of the cobble transects (2, 9, 33) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Grasses									
Agropyron repens (Quackgrass)	-	-	-	-	-	-	-	-	50
Bromus tectorum (Cheatgrass brome)	28	5-50	37.50	0.05-0.70	-	-	-	-	100
Elymus cinereus (Giant wildrye)	-	-	-	-	-	-	-	-	50
Festuca microstachys (Small fescue)	30	-	0.30	-	-	-	-	-	50
Stipa comata (Needle-and-thread)	-	-	-	-	-	-	-	-	50
Forbs									
Achillea millefolium (Yarrow)	50	-	1.00	-	-	-	-	-	50
Brassica spp. (Mustard)	85	-	1.45	-	-	-	-	-	50
Brodiaea douglasii (Douglas brodiea)	-	-	-	-	-	-	-	-	50
Erigeron compositus (Dwarf mountain fleabane)	5	-	0.10	-	-	-	-	-	50
Eriogonum compositum (Northern buckwheat)	15	-	0.20	-	-	-	-	-	50
Lomatium dissectum (Carrotleaf leptotaenia)	10	-	0.10	-	-	-	-	-	50
Lupinus spp. (Lupine)	30	-	0.35	-	-	-	-	-	50
Oenothera pallida (Pale eveningprimrose)	-	-	-	-	-	-	-	-	50
Plantago patogonica (Indianwheat)	-	-	-	-	-	-	-	-	50
Rumex venosus (Veiny dock)	-	-	-	-	-	-	-	-	50
Salsola kali tenuifolia (Russianthistle)	-	-	-	-	-	-	-	-	50
Unknown	15	-	0.15	-	-	-	-	-	50
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	323	-	1.83	-	33
Artemisia tripartita (Threetip sagebrush)	-	-	-	-	-	-	-	-	33
Chrysothamnus nauseosus (Rubber rabbitbrush)	-	-	-	-	-	-	-	-	33
Chrysothamnus viscidiflorus (Tall green rabbitbrush)	-	-	-	-	-	-	-	-	33
Trees									
Juniperus occidentalis (Western juniper)	-	-	-	-	108	-	0.61	-	33
Vegetation	83	65-100	2.08	0.80-3.35					
Litter	90	85-95	21.83	1.15-42.50					
Rock	73	45-100	58.65	19.35-97.95					
Erosion pavement	0	-	0.00	-					
Bare ground	40	5-75	17.45	0.10-34.80					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

[c]Because transect 33 was not sampled for grasses, grasslike plants, and forbs, it was omitted from calculation.

One of the cobble transects (2) contained three species of shrub, none of them abundant enough to be measured, and the dominant ground plant was mustard with 85% occurrence. A second cobble transect (9) contained no shrubs, and the dominant ground plant was lupine with 30% occurrence. The third cobble transect (33) was not sampled for ground vegetation. It contained one species of shrub -- Saskatoon serviceberry with a density of 323 stems per ha averaging 1.8 m tall, and one species of tree -- western juniper with a density of 108 stems per ha averaging 0.6 m tall.

Overall, the frequency of occurrence of live vegetation was 83%, with 2% basal coverage, 65% frequency for litter, with 16% basal coverage, 82% frequency for rock, with 71% basal coverage, and 27% frequency for bare ground, with 12% basal coverage.

Conifer (Tables 20, 21, 22, 23, Appendix E Transect 62)

Extensive coniferous growth does not occur until Lake Franklin D. Roosevelt. Along Rufus Woods Lake the coniferous growth is a narrow band paralleling the river just above high water. Up until RM 675 near Gifford, the shrub layer under the conifers tends toward the shrub steppe type. North of RM 675, the shrub layer is mostly macrophyllus. Twelve transects were located along the Rufus Woods Lake, South FDR, North FDR, and British Columbia segments. This broad habitat type was divided into five transects of ponderosa pine with shrub steppe, four transects of ponderosa pine with macrophyllus shrub, two transects of ponderosa pine with no measurable shrub layer, and one transect of western juniper. Although not extensive, juniper communities had a wide distribution from Hanford to Northport.

Altogether, 121 species of grasses were recorded, of which 16 occurred on the shrub steppe, 11 on the broadleaf shrub, five on the no shrub, and eight on the juniper transects. Bluebunch wheatgrass and cheatgrass each appeared on 8 (67%) of the transects. Canada bluegrass occurred on 5 (42%) transects, but had the highest frequency (32%) and ground cover (0.57) on the occupied transects. It did not occur on the ponderosa pine -- shrub steppe transects. Fifteen species (71%) each occurred on three or less of the transects.

Two species of grasslike plants occurred on the ponderosa pine-shrub steppe transects, and one species on the ponderosa pine-no shrub transects.

Altogether, 49 species of forbs occurred on the transects, of which 26 (53%) occurred individually on only one transect. The ponderosa pine-shrub steppe transects had 30 species of forbs, the ponderosa pine-broadleaf shrub transects had 25 species, the ponderosa pine-no shrub transects had 12 species, and the juniper transect had 4 species. Lupine occurred on 83% of the transects, and yarrow on 75%.

Table 20. Vegetation of the conifer transects (44, 47, 50, 51, 54, 56, 57, 58, 59, 61, 62, 67) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	18	15-25	0.17	0.15-0.22	-	-	-	-	25
Agropyron spicatum (Bluebunch wheatgrass)	19	5-40	0.47	0.05-1.70	-	-	-	-	67
Agrostis alba (Redtop)	-	-	-	-	-	-	-	-	17
Bromus inermis (Smooth brome)	-	-	-	-	-	-	-	-	8
Bromus japonicus (Japanese brome)	18	5-40	0.21	0.05-0.40	-	-	-	-	42
Bromus tectorum (Cheatgrass brome)	28	10-50	0.45	0.10-0.85	-	-	-	-	67
Calamagrostis rubescens (Pinegrass)	5	-	0.05	-	-	-	-	-	17
Danthonia spicata (Poverty oatgrass)	15	-	0.60	-	-	-	-	-	8
Elymus cinereus (Giant wildrye)	-	-	-	-	-	-	-	-	17
Festuca idahoensis (Idaho fescue)	5	-	0.25	-	-	-	-	-	17
Festuca occidentalis (Western fescue)	8	5-10	0.55	0.10-1.00	-	-	-	-	25
Koelaria cristata (Prairie junegrass)	10	-	0.11	0.07-0.15	-	-	-	-	50
Poa bulbosa (Bulbous bluegrass)	5	-	0.08	0.05-0.10	-	-	-	-	17
Poa compressa (Canada bluegrass)	32	5-80	0.57	0.05-1.40	-	-	-	-	42
Poa juncifolia (Alkali bluegrass)	-	-	-	-	-	-	-	-	17
Poa sandbergii (Sandberg bluegrass)	8	5-15	0.12	0.05-0.20	-	-	-	-	42
Stipa comata (Needle-and-thread)	10	-	0.20	-	-	-	-	-	25
Stipa richardsonii (Richardson needlegrass)	5	-	0.05	-	-	-	-	-	17
Stipa spartea (Porcupine grass)	5	-	0.05	-	-	-	-	-	8
Stipa viridula (Green needlegrass)	10	-	0.50	-	-	-	-	-	8
Unknown	5	-	0.05	-	-	-	-	-	8
Grasslike plants									
Carex geyeri (Elk sedge)	5	-	0.10	-	-	-	-	-	17
Juncus balticus (Baltic rush)	5	-	0.05	-	-	-	-	-	8
Forbs									
Achillea millefolium (Yarrow)	8	5-10	0.08	0.05-0.10	-	-	-	-	75
Agoseris spp. (Agoseris)	-	-	-	-	-	-	-	-	8
Allium cernuum (Nodding onion)	-	-	-	-	-	-	-	-	8
Antennaria rosea (Rose pussytoes)	-	-	-	-	-	-	-	-	25
Apocynum androsaemifolium (Spreading dogbone)	-	-	-	-	-	-	-	-	17
Asparagus officinalis (Garden asparagus)	-	-	-	-	-	-	-	-	8
Aster spp. (Aster)	-	-	-	-	-	-	-	-	8
Astragalus spp. (Milkvetch, locoweed)	5	-	0.05	-	-	-	-	-	8
Balsamorhiza sagittata (Arrowleaf balsamroot)	15	-	0.30	-	-	-	-	-	58

Table 20. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Forbs (cont.)									
Besseya rubra (Kittentails)	-	-	-	-	-	-	-	-	17
Brodiaea douglasii (Douglas brodiea)	-	-	-	-	-	-	-	-	8
Centaurea spp. (Centaurea, knapweed)	25	5-45	0.91	0.05-1.77	-	-	-	-	25
Clarkia pulchella (Elkhorns clarkia)	-	-	-	-	-	-	-	-	33
Collomia linearis (Narrowleaf collomia)	13	5-20	12.50	0.05-0.20	-	-	-	-	33
Cryptantha spp. (Cryptantha)	-	-	-	-	-	-	-	-	8
Cymopteris terebinthinus	-	-	-	-	-	-	-	-	17
Equisetum hyemale (Western scouringrush)	-	-	-	-	-	-	-	-	8
Erigeron subtrinervis (Threenerve fleabane)	-	-	-	-	-	-	-	-	8
Erodium cicutarium (Storksbill)	-	-	-	-	-	-	-	-	8
Filago arvensis	-	-	-	-	-	-	-	-	8
Fragaria vesca (Woods strawberry)	8	5-10	0.06	0.05-0.07	-	-	-	-	17
Galium boreale (Northern bedstraw)	8	5-10	0.10	0.05-0.15	-	-	-	-	25
Geum triflorum (Prairiesmoke avens)	-	-	-	-	-	-	-	-	8
Gilia aggregata (Skyrocket gilia)	-	-	-	-	-	-	-	-	25
Hackelia floribunda (Showy stickseed)	-	-	-	-	-	-	-	-	8
Heuchera spp. (Alumroot)	-	-	-	-	-	-	-	-	8
Lepidium perfoliatum (Clasping pepperweed)	-	-	-	-	-	-	-	-	17
Lewisia rediviva (Bitterroot lewisia)	-	-	-	-	-	-	-	-	8
Lithospermum ruderale (Western gromwell)	10	-	0.20	-	-	-	-	-	42
Lomatium dissectum (Carrotleaf leptotaenia)	-	-	-	-	-	-	-	-	8
Lomatium spp. (Biscuitroot, lomatium)	-	-	-	-	-	-	-	-	17
Lupinus spp. (Lupine)	22	5-40	0.30	0.05-0.57	-	-	-	-	83
Montia spp. (Indianlettuce)	-	-	-	-	-	-	-	-	25
Opuntia polycantha (Plains pricklypear)	-	-	-	-	-	-	-	-	8
Penstemon spp. (Penstemon, beardtongue)	-	-	-	-	-	-	-	-	8
Phacelia linearis (Threadleaf phacelia)	-	-	-	-	-	-	-	-	17
Plantago patogonica (Indianwheat)	-	-	-	-	-	-	-	-	8
Pterospora andromedea(Woodland pinedrops)	-	-	-	-	-	-	-	-	8
Rudbeckia hirta (Blackeyedsusan)	-	-	-	-	-	-	-	-	8
Rumex spp. (Dock, sorrel)	5	-	0.05	-	-	-	-	-	17
Scutellaria angustifolia (Narrow skullcap)	-	-	-	-	-	-	-	-	25
Sedum stenopetalum (Wormleaf stonecrop)	-	-	-	-	-	-	-	-	8
Smilacina racemosa (Feather solomonplume)	10	-	0.07	-	-	-	-	-	8
Smilacina stellata (Starry solomonplume)	-	-	-	-	-	-	-	-	8
Tragopogon dubius (Yellow salsify)	-	-	-	-	-	-	-	-	42
Unknown	35	-	0.50	-	-	-	-	-	25
Verbascum blattaria (Moth mullein)	-	-	-	-	-	-	-	-	8
Verbascum thapsus (Flannel mullein)	5	-	0.05	-	-	-	-	-	8
Vicia americana (American vetch)	-	-	-	-	-	-	-	-	17

Table 20. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Shrubs									
Acer glabrum (Rockymountain maple)	-	-	-	-	-	-	-	-	8
Amelanchier alnifolia (Saskatoon serviceberry)	15	5-35	8.32	2.20-25.90	619	108-1506	1.81	0.31-3.66	75
Arctostaphylos uva-ursi (Bearberry)	-	-	-	-	-	-	-	-	25
Artemisia tridentata (Big sagebrush)	-	-	-	-	108	-	0.61	-	8
Berberis repens (Low oregongrape)	-	-	-	-	4196	-	0.21	-	25
Chrysothamnus nauseosus (Rubber rabbitbrush)	15	10-20	4.05	2.30-5.80	251	215-323	0.52	0.36-0.71	33
Chrysothamnus viscidiflorus (Tall green rabbitbrush)	-	-	-	-	-	-	-	-	17
Cornus stolonifera (Red-osier dogwood)	-	-	-	-	-	-	-	-	8
Corylus cornuta	-	-	-	-	323	-	1.83	-	17
Crataegus columbiana (Columbia hawthorn)	5	-	0.30	-	430	-	3.12	-	17
Crataegus douglasii (Black hawthorn)	-	-	-	-	215	-	0.97	-	25
Eriogonum douglasii (Douglas buckwheat)	-	-	-	-	-	-	-	-	42
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	33
Holodiscus discolor (Creambush oceanspray)	-	-	-	-	-	-	-	-	17
Leptodactylon pungens (Granitegilia)	-	-	-	-	-	-	-	-	8
Philadelphus lewisii (Mockorange)	30	5-80	9.33	0.20-25.80	-	-	-	-	33
Prunus virginiana (Common chokecherry)	-	-	-	-	1076	-	0.52	0.37-0.66	67
Purshia tridentata (Antelope bitterbrush)	40	35-50	20.93	14.20-33.30	1533	646-2367	1.26	1.01-1.37	33
Rhus glabra (Smooth sumac)	20	-	5.20	-	1291	-	0.41	-	8
Rhus radicans (Poison ivy)	-	-	-	-	108	-	0.15	-	25
Ribes cereum (Wax currant)	10	-	0.80	-	-	-	-	-	17
Rosa acicularis (Prickly rose)	-	-	-	-	216	108-323	3.41	0.71-6.10	17
Rosa gymnocarpa (Baldhip rose)	5	-	0.90	0.80-1.00	-	-	-	-	25
Rosa spp. (Rose)	-	-	-	-	1076	753-1399	1.72	0.52-2.92	17
Rosa woodsii (Woods rose)	15	-	6.00	-	-	-	-	-	25
Salva dorri (Purple sage)	-	-	-	-	-	-	-	-	8
Sambucus cerulea (Blue elderberry)	-	-	-	-	-	-	-	-	8
Spiraea douglasii (Douglas spirea)	20	-	8.00	-	215	-	0.76	-	33
Symphoricarpos albus (Common snowberry)	20	10-30	5.35	3.10-7.60	11,118	215-29,588	0.53	0.37-0.66	33
Trees									
Betula occidentalis (Water birch)	10	-	10.70	-	-	-	-	-	8
Juniperus occidentalis (Western juniper)	14	5-25	8.65	3.40-17.00	431	108-861	6.88	1.49-13.41	42
Pinus ponderosa (Ponderosa pine)	47	10-90	40.73	4.00-89.90	861	215-1614	9.97	3.65-18.29	100
Psuedotsuga menziesii (Douglas-fir)	-	-	-	-	1614	-	6.65	-	25
Pyrus malus (Apple)	-	-	-	-	108	-	4.57	-	8

Table 20. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Vegetation	57	15-95	1.88	0.30-4.95					
Litter	98	85-100	74.33	20.20-97.65					
Rock	15	0-70	3.14	0.00-14.65					
Erosion pavement	0	-	0.00	-					
Bare ground	45	5-95	20.64	0.25-70.15					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 21. Vegetation of the ponderosa pine-shrub steppe transects (44, 50, 51, 54, 56) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	15	-	0.15	-	-	-	-	-	20
Agropyron spicatum (Bluebunch wheatgrass)	25	5-40	0.72	0.10-1.70	-	-	-	-	80
Agrostis alba (Redtop)	-	-	-	-	-	-	-	-	20
Bromus inermis (Smooth brome)	-	-	-	-	-	-	-	-	20
Bromus japonicus (Japanese brome)	28	15-40	0.35	0.30-0.40	-	-	-	-	60
Bromus tectorum (Cheatgrass brome)	35	25-50	0.64	0.35-0.85	-	-	-	-	60
Calamagrostis rubescens (Pinegrass)	5	-	0.05	-	-	-	-	-	20
Festuca idahoensis (Idaho fescue)	5	-	0.25	-	-	-	-	-	40
Festuca occidentalis (Western fescue)	5	-	1.00	-	-	-	-	-	40
Koelaria cristata (Prairie junegrass)	-	-	-	-	-	-	-	-	40
Poa bulbosa (Bulbous bluegrass)	5	-	0.10	-	-	-	-	-	20
Poa juncifolia (Alkali bluegrass)	-	-	-	-	-	-	-	-	40
Poa sandbergii (Sandberg bluegrass)	10	5-15	0.13	0.05-0.20	-	-	-	-	60
Stipa comata (Needle-and-thread)	10	-	0.20	-	-	-	-	-	40
Stipa richardsonii (Richardson needlegrass)	-	-	-	-	-	-	-	-	20
Stipa viridula (Green needlegrass)	10	-	0.50	-	-	-	-	-	20
Grasslike plants									
Carex geyeri (Elk sedge)	-	-	-	-	-	-	-	-	20
Juncus balticus (Baltic rush)	5	-	0.05	-	-	-	-	-	20
Forbs									
Achillea millefolium (Yarrow)	10	-	0.10	-	-	-	-	-	80
Agoseris spp. (Agoseris)	-	-	-	-	-	-	-	-	20
Antennaria rosea (Rose pussytoes)	-	-	-	-	-	-	-	-	40
Aster spp. (Aster)	-	-	-	-	-	-	-	-	20
Astragalus spp. (Aster)	5	-	0.05	-	-	-	-	-	20
Balsamorhiza sagittata (Arrowleaf balsamroot)	-	-	-	-	-	-	-	-	80
Besseya rubra (Kittentails)	-	-	-	-	-	-	-	-	40
Brodiaea douglasii (Douglas brodiea)	-	-	-	-	-	-	-	-	20
Clarkia pulchella (Elkhorns clarkia)	-	-	-	-	-	-	-	-	40
Collomia linearis (Narrowleaf collomia)	13	5-20	12.50	0.05-0.20	-	-	-	-	60
Cryptantha (Cryptantha)	-	-	-	-	-	-	-	-	20
Cymopteris terebinthinus	-	-	-	-	-	-	-	-	40
Erodium cicutarium (Filaree storksbill)	-	-	-	-	-	-	-	-	20
Fragaria vesca (Woods strawberry)	5	-	0.05	-	-	-	-	-	20

Table 21. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Forbs (cont.)									
Galium boreale (Norhtern bedstraw)	10	-	0.15	-	-	-	-	-	20
Geum triflorum (Prairiesmoke avens)	-	-	-	-	-	-	-	-	20
Hackelia floribunda (Showy stickseed)	-	-	-	-	-	-	-	-	20
Heuchera spp. (Alumroot)	-	-	-	-	-	-	-	-	20
Lepidium perfoliatum (Clasping pepperweed)	-	-	-	-	-	-	-	-	20
Lithospermum ruderale (Western gromwell)	-	-	-	-	-	-	-	-	80
Lomatium spp. (Biscuitroot, lomatium)	-	-	-	-	-	-	-	-	40
Lupinus spp. (Lupine)	40	-	0.57	-	-	-	-	-	100
Montia spp. (Indianlettuce)	-	-	-	-	-	-	-	-	20
Opuntia polycantha (Plains pricklypear)	-	-	-	-	-	-	-	-	20
Phacelia linearis (Threadleaf phacelia)	-	-	-	-	-	-	-	-	60
Rudbeckia hirta (Blackeyedsusan)	-	-	-	-	-	-	-	-	20
Scutellaria angustifolia (Narrow skullcap)	-	-	-	-	-	-	-	-	60
Smilacina racemosa (Feather solomonplume)	10	-	0.07	-	-	-	-	-	20
Tragopogon dubius (Yellow salsify)	-	-	-	-	-	-	-	-	60
Vicia americana (American vetch)	-	-	-	-	-	-	-	-	40
Shrubs									
Acer glabrum (Rockymountain maple)	-	-	-	-	-	-	-	-	20
Amelanchier alnifolia (Saskatoon serviceberry)	18	10-35	10.23	2.20-25.90	807	108-1506	1.99	0.31-3.66	60
Artemisia tridentata (Big sagebrush)	-	-	-	-	108	-	0.61	-	20
Chrysothamnus nauseosus (Rubber rabbitbrush)	20	-	5.80	-	251	215-323	0.52	0.36-0.71	60
Chrysothamnus viscidiflorus (Tall green rabbitbrush)	-	-	-	-	-	-	-	-	40
Crataegus douglasii (Black hawthorn)	-	-	-	-	-	-	-	-	20
Eriogonum douglasii (Douglas buckwheat)	-	-	-	-	-	-	-	-	60
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	60
Holodiscus discolor (Creambush oceanspray)	-	-	-	-	-	-	-	-	40
Leptodactylon pungens (Granitegilia)	-	-	-	-	-	-	-	-	20
Philadelphus lewisii (Mockorange)	30	5-80	9.33	0.20-25.80	-	-	-	-	80
Prunus virginiana (Common chokecherry)	-	-	-	-	1076	-	0.37	-	80
Purshia tridentata (Antelope bitterbrush)	40	35-50	20.93	14.20-33.30	1533	646-2367	1.26	1.01-1.37	80
Rhus glabra (Smooth sumac)	20	-	5.20	-	1291	-	0.41	-	20
Rhus radicans (Poison ivy)	-	-	-	-	-	-	-	-	20
Ribes cereum (Wax currant)	10	-	0.80	-	-	-	-	-	40
Rosa gymnocarpa (Baldhip rose)	5	-	0.80	-	-	-	-	-	40
Salvia dorri (Purple sage)	-	-	-	-	-	-	-	-	20
Sambucus cerulea (Blue elderberry)	-	-	-	-	-	-	-	-	20
Spiraea douglasii (Douglas spirea)	20	-	8.00	-	-	-	-	-	40

Table 21. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Trees									
Juniperus occidentalis (Western juniper)	10	-	7.30	-	108	-	9.14	-	20
Pinus ponderosa (Ponderosa pine)	65	40-90	61.95	34.00-89.90	681	215-1614	10.36	3.65-18.29	100
Psuedotsuga menziesii (Douglas-fir)	-	-	-	-	1614	-	6.65	-	40
Vegetation	50	15-90	2.54	0.90-4.95					
Litter	97	85-100	80.47	62.00-96.90					
Rock	25	0-70	5.68	0.00-14.65					
Erosion pavement	0	-	0.00	-					
Bare ground	23	5-45	11.31	0.25-23.80					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 22. Vegetation of the ponderosa pine-broadleaf shrub transects (47, 57, 61, 67) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	25	-	0.22	-	-	-	-	-	25
Agropyron spicatum (Bluebunch wheatgrass)	10	5-15	0.11	0.05-0.17	-	-	-	-	100
Bromus japonicus (Japanese brome)	8	5-10	0.08	0.05-0.10	-	-	-	-	50
Bromus tectorum (Cheatgrass brome)	18	10-25	0.18	0.10-0.25	-	-	-	-	50
Calamagrostis rubescens (Pinegrass)	-	-	-	-	-	-	-	-	25
Elymus cinereus (Giant wildrye)	-	-	-	-	-	-	-	-	50
Koeleria cristata (Prairie junegrass)	10	-	0.07	-	-	-	-	-	50
Poa bulbosa (Bulbous bluegrass)	5	-	0.05	-	-	-	-	-	25
Poa compressa (Canada bluegrass)	43	5-80	0.73	0.05-1.40	-	-	-	-	75
Poa sandbergii (Sandberg bluegrass)	10	-	0.12	0.07-0.17	-	-	-	-	50
Stipa spartea (Porcupine grass)	5	-	0.05	-	-	-	-	-	25
Forbs									
Achillea millefolium (Yarrow)	5	-	0.05	-	-	-	-	-	75
Allium cernuum (Nodding onion)	-	-	-	-	-	-	-	-	25
Apocynum androsaemifolium (Spreading dogbane)	-	-	-	-	-	-	-	-	50
Balsamorhiza sagittata (Arrowleaf balsomroot)	15	-	0.30	-	-	-	-	-	50
Centaurea spp. (Centaurea, knapweed)	5	-	0.05	-	-	-	-	-	50
Clarkia pulchella (Elkhorns clarkia)	-	-	-	-	-	-	-	-	50
Collomia linearis (Narrowleaf collomia)	-	-	-	-	-	-	-	-	25
Equisetum hyemale (Western scouringrush)	-	-	-	-	-	-	-	-	25
Erigeron subtrinervis (Threenerve fleabane)	-	-	-	-	-	-	-	-	25
Fragaria vesca (Woods strawberry)	10	-	0.07	-	-	-	-	-	25
Galium boreale (Northern bedstraw)	8	5-10	0.08	0.05-0.10	-	-	-	-	50
Gilia aggregate (Skyrocket gilia)	-	-	-	-	-	-	-	-	50
Lepidium perfoliatum (Clasping pepperweed)	-	-	-	-	-	-	-	-	25
Lithospermum ruderale (Western gromwell)	10	-	0.20	-	-	-	-	-	50
Lomatium dissectum (Carrotleaf leptotaenia)	-	-	-	-	-	-	-	-	25
Lupinus spp. (Lupine)	12	5-25	0.14	0.05-0.32	-	-	-	-	75
Montia spp. (Indianlettuce)	-	-	-	-	-	-	-	-	25
Penstemon spp. (Penstemon, beardtongue)	-	-	-	-	-	-	-	-	25
Pterospora andromedea (Woodland pinedrops)	-	-	-	-	-	-	-	-	25
Rumex spp. (Dock, sorrel)	5	-	0.05	-	-	-	-	-	25
Sedum stenopetalum (Wormleaf stonecrop)	-	-	-	-	-	-	-	-	25
Tragopogon dubius (Yellow salsify)	-	-	-	-	-	-	-	-	50
Unknown	-	-	-	-	-	-	-	-	25
Verbascum blattaria (Moth mullein)	-	-	-	-	-	-	-	-	25
Verbascum thapsus (Flannel mullein)	5	-	0.05	-	-	-	-	-	25

Table 22. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	12	5-15	6.40	3.40-11.60	431	108-753	1.63	0.76-2.50	100
Arctostaphylos uva-ursi (Bearberry)	-	-	-	-	-	-	-	-	25
Berberis repens (Low oregongrape)	-	-	-	-	4196	-	0.12	-	50
Chrysothamnus nauseosus (Rubber rabbitbrush)	10	-	2.30	-	-	-	-	-	25
Cornus stolonifera (Red-osier dogwood)	-	-	-	-	-	-	-	-	25
Corylus cornuta	-	-	-	-	323	-	1.83	-	50
Crataegus columbiana (Columbia hawthorn)	5	-	0.30	-	430	-	3.12	-	50
Crataegus douglasii (Black hawthorn)	-	-	-	-	215	-	0.97	-	50
Prunus virginiana (Common chokecherry)	-	-	-	-	1076	-	0.66	-	75
Rhus radicans (Poison ivy)	-	-	-	-	108	-	0.15	-	50
Rosa acicularis (Prickly rose)	-	-	-	-	216	108-323	3.41	0.71-6.10	50
Rosa spp. (Rose)	-	-	-	-	1076	753-1399	1.72	0.52-2.92	50
Rosa woodsii (Woods rose)	15	-	6.00	-	-	-	-	-	75
Spiraea douglasii (Douglas spirea)	-	-	-	-	215	-	0.76	-	50
Symphoricarpos albus (Common snowberry)	20	10-30	5.35	3.10-7.60	11,118	215-29,588	0.37-0.66		75
Trees									
Betula occidentalis (Water birch)	10	-	10.70	-	-	-	-	-	25
Juniperus occidentalis (Western juniper)	15	5-25	10.20	3.40-17.00	108	-	1052	7.62-13.41	50
Pinus ponderosa (Ponderosa pine)	45	10-75	37.30	4.00-71.80	807	430-1076	10.01	5.94-13.92	100
Psuedotsuga menziesii (Douglas-fir)	-	-	-	-	-	-	-	-	25
Pyrus malus (Apple)	-	-	-	-	108	-	4.57	-	25
Vegetation	78	65-95	1.51	0.95-2.05					
Litter	99	95-100	69.41	20.20-97.65					
Rock	14	0-50	2.28	0.00-7.60					
Erosion pavement	0	-	0.00	-					
Bare ground	51	15-95	26.80	1.40-70.15					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 23. Vegetation of the ponderosa pine transects without shrub cover (58, 59), June 1974.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Bromus tectorum (Cheatgrass brome)	-	-	-	-	-	-	-	-	100
Festuca occidentalis (Western fescue)	10	-	0.10	-	-	-	-	-	50
Koelaria cristata (Prairie junegrass)	-	-	-	-	-	-	-	-	50
Poa compressa (Canada bluegrass)	-	-	-	-	-	-	-	-	50
Stipa richardsonii (Richardson needlegrass)	5	-	0.05	-	-	-	-	-	50
Grasslike plants									
Carex geyeri (Elk sedge)	5	-	0.10	-	-	-	-	-	50
Forbs									
Achillea millefolium (Yarrow)	-	-	-	-	-	-	-	-	100
Antennaria rosea (Rose pussytoes)	-	-	-	-	-	-	-	-	50
Balsamorhiza sagittata (Arrowleaf balsamroot)	-	-	-	-	-	-	-	-	50
Filago arvensis	-	-	-	-	-	-	-	-	50
Gilia aggregata (Skyrocket gilia)	-	-	-	-	-	-	-	-	50
Lewisia rediviva (Bitterroot lewisia)	-	-	-	-	-	-	-	-	50
Lupinus spp. (Lupine)	35	-	0.50	-	-	-	-	-	100
Montia spp. (Indianlettuce)	-	-	-	-	-	-	-	-	50
Phacelia linearis (Threadleaf phacelia)	-	-	-	-	-	-	-	-	50
Plantago patogonica (Indianwheat)	-	-	-	-	-	-	-	-	50
Rumex spp. (Dock, sorrel)	-	-	-	-	-	-	-	-	50
Unknown	35	0.50	-	-	-	-	-	-	100
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	-	-	-	-	50
Arctostaphylos uva-ursi (Bearberry)	-	-	-	-	-	-	-	-	100
Berberis repens (Low oregongrape)	-	-	-	-	-	-	-	-	50
Eriogonum douglasii (Douglas buckwheat)	-	-	-	-	-	-	-	-	100
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	50
Prunus virginiana (Common chokecherry)	-	-	-	-	-	-	-	-	50
Spiraea douglasii (Douglas spirea)	-	-	-	-	-	-	-	-	50
Symphoricarpos albus (Common snowberry)	-	-	-	-	-	-	-	-	50

Table 23. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Trees									
Juniperus occidentalis (Western juniper)	-	-	-	-	646	-	2.76	-	50
Pinus ponderosa (Ponderosa pine)	33	20-45	24.65	13.10-36.20	1237	753-1721	9.30	8.9309.66	100
Vegetation	30	25-35	0.45	0.30-0.60					
Litter	100	-	84.45	80.35-88.55					
Rock	3	0-5	0.10	0.00-0.20					
Erosion pavement	0	-	0.00	-					
Bare ground	60	45-75	15.00	10.95-19.05					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Altogether, 29 species of shrubs were recorded, of which seven (24%) occurred individually on only one transect. The shrubs were distributed as follows: 20 species on ponderosa pine-shrub steppe, 15 on ponderosa pine-broadleaf shrub, 8 on ponderosa pine-no (measurable) shrub, and 2 on the juniper transect. Of the shrubs on the ponderosa pine-shrub steppe transects, bitterbrush was dominant, occurring on 80% of the transects in a density of 1533 stems per ha. Saskatoon serviceberry occurred on 100% of the ponderosa pine-broadleaf shrub transects in a density of 431 stems per ha. Though not as widespread, other broadleaf shrubs were more dense where they occurred. Snowberry, for example, occurred on only 75% of the ponderosa pine-broadleaf shrub transects, but in a density of 11,118 stems per ha. Of the eight shrubs occurring on the ponderosa pine-no shrub transects, none occurred in sufficient abundance to be measured, and only two -- bearberry and Douglas buckwheat -- occurred on both transects of this community. Two species of sparse shrub occurred on the juniper transect.

Altogether, five species of trees were recorded, of which only ponderosa pine occurred on all the transects, in a density of 861 stems per ha, averaging 10 m tall. Juniper occurred on five (42%) transects. Three species of tree occurred on the ponderosa pine-shrub steppe transects, all five occurred on the ponderosa pine-broadleaf shrub transects, two occurred on the ponderosa pine-no shrub transects, and two on the juniper transect. The density of ponderosa pine was 681 stems per ha on the pine-shrub steppe transects, 807 on the pine-broadleaf shrub transects, 1237 on the pine-no shrub transects, and sparse on the juniper transect.

Litter dominated the basal coverage at 74%, with 2% for live vegetation, 3% for rock, and 21% for bare ground. Litter occurred in a frequency of 98%, compared to 57% for live vegetation, 15% for rock, and 45% for bare ground.

Shrub steppe (Tables 24, 25, 26, 27, 28)

Nineteen transects were located within this general most extensive habitat type in the study area. They were examined as a group containing the following sub-groups named for the dominant shrub: sagebrush with nine transects, bitterbrush with three transects, rabbitbrush with four transects, and a group of one transect each of spring hopsage, granitegilia and purple sage. These shrub-steppe transects were located in the Hanford, Priest Rapids, Wanapum, Rock Island, Rocky Reach, Wells, Rufus Woods Lake, and South FDR segments.

Altogether, 19 species of grasses were recorded, of which cheatgrass, occurred on 83% of the transects in a frequency of 62%, and Sandberg bluegrass occurred on 67% of the transects. Nine (47%) of the species occurred individually on only one transect. Of the 19 species, 13 occurred on the sagebrush transects, 7 on the bitterbrush transects,

Table 24. Vegetation of the shrub steppe transects (1, 4, 7, 13, 18, 19, 20, 26, 28, 31, 32, 37, 41, 43, 45, 46, 49, 53, 55) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)[c]
Grasses									
Agropyron cristatum (Fairway crested wheatgrass)	30	-	0.27	-	-	-	-	-	6
Agropyron repens (Quackgrass)	20	15-25	0.21	0.20-0.22	-	-	-	-	17
Agropyron spicatum (Bluebunch wheatgrass)	28	5-50	1.23	0.15-2.30	-	-	-	-	56
Agrostis alba (Redtop)	-	-	-	-	-	-	-	-	6
Agrostis spica-venti (Bentgrass)	10	-	0.15	-	-	-	-	-	6
Bromus brizaeformis (Rattle brome)	-	-	-	-	-	-	-	-	6
Bromus inermis (Smooth brome)	-	-	-	-	-	-	-	-	6
Bromus japonicus (Japanese brome)	40	5-90	0.63	0.27-1.12	-	-	-	-	22
Bromus tectorum (Cheatgrass brome)	62	5-100	1.10	0.05-2.65	-	-	-	-	83
Elymus cinereus (Giant wildrye)	-	-	-	-	-	-	-	-	17
Festuca idahoensis (Idaho fescue)	15	-	1.25	-	-	-	-	-	6
Festuca microstachys (Small fescue)	23	10-35	0.23	0.10-0.35	-	-	-	-	11
Koelaria cristata (Prairie junegrass)	-	-	-	-	-	-	-	-	6
Oryzopsis hymenoides (Indian ricegrass)	5	-	0.05	-	-	-	-	-	39
Poa bulbosa (Bulbous bluegrass)	-	-	-	-	-	-	-	-	11
Poa sandbergii (Sandberg bluegrass)	21	5-50	0.40	0.05-1.47	-	-	-	-	67
Stipa comata (Needle-and-thread)	14	5-30	0.47	0.05-1.20	-	-	-	-	61
Stipa richardsonii (Richardson needlegrass)	-	-	-	-	-	-	-	-	6
Stipa viridula (Green needlegrass)	-	-	-	-	-	-	-	-	6
Forbs									
Achillea millefolium (Yarrow)	10	5-20	0.10	0.05-0.20	-	-	-	-	44
Agoseris spp. (Agoseris)	-	-	-	-	-	-	-	-	11
Allium cernuum (Nodding onion)	-	-	-	-	-	-	-	-	6
Antennaria rosea (Rose pussytoes)	-	-	-	-	-	-	-	-	6
Aster spp. (Aster)	10	-	0.20	-	-	-	-	-	11
Astragalus spp. (Milkvetch, locoweed)	-	-	-	-	-	-	-	-	6
Balsamorhiza sagittata (Arrowleaf balsamroot)	10	-	0.20	-	-	-	-	-	28
Brassica spp. (Mustard)	22	5-40	0.37	0.30-0.50	-	-	-	-	33
Brodiaea douglasii (Douglas brodiea)	-	-	-	-	-	-	-	-	22
Calochortus nuttallii (Segolily)	-	-	-	-	-	-	-	-	6
Castilleja spp. (Indian paintbrush)	10	-	0.10	-	-	-	-	-	11
Centaurea diffusa	5	-	0.05	-	-	-	-	-	6
Centaurea spp. (Centaurea, knapweed)	-	-	-	-	-	-	-	-	6
Centaurium spp. (Centaurium)	-	-	-	-	-	-	-	-	6
Cerastium arvense (Starry cerastium)	40	-	0.45	-	-	-	-	-	11

Table 24. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Forbs (cont.)									
Clematis ligusticifolia (Western virginsbower)	-	-	-	-	-	-	-	-	11
Cryptantha leucophaea	7	5-10	0.07	0.05-0.10	-	-	-	-	17
Cryptantha spp. (Cryptantha)	5	-	0.05	-	-	-	-	-	11
Cymopterus terebinthinus	10	-	0.55	-	-	-	-	-	11
Erigeron spp. (Fleabane, daisy)	5	-	0.02	-	-	-	-	-	6
Filago arvensis	10	5-15	0.10	0.05-0.15	-	-	-	-	39
Galium boreale (Northern bedstraw)	-	-	-	-	-	-	-	-	6
Lepidium perfoliatum (Clasping pepperweed)	-	-	-	-	-	-	-	-	17
Lithospermum ruderale (Western gromwell)	-	-	-	-	-	-	-	-	11
Lomatium dissectum (Carrotleaf leptotaenia)	-	-	-	-	-	-	-	-	6
Lomatium spp. (Biscuitroot, lomatium)	-	-	-	-	-	-	-	-	11
Lupinus spp. (Lupine)	-	-	-	-	-	-	-	-	22
Medicago sativia (Alfalfa)	-	-	-	-	-	-	-	-	6
Oenothera pallida (Pale eveningprimrose)	15	-	0.12	-	-	-	-	-	11
Opuntia polycantha (Plains pricklypear)	5	-	0.50	-	-	-	-	-	22
Orobanche uniflora minuta (Naked broomrape)	-	-	-	-	-	-	-	-	6
Orthocarpus luteus (Yellow owlclover)	-	-	-	-	-	-	-	-	6
Oxytropis spp. (Crazeweed)	-	-	-	-	-	-	-	-	6
Phacelia linearis (Threadleaf phacelia)	8	5-10	0.08	0.05-0.10	-	-	-	-	22
Rumex venosus (Veiny dock)	40	-	0.80	-	-	-	-	-	6
Salsola kali tenuifolia (Russianthistle)	-	-	-	-	-	-	-	-	6
Scutellaria angustifolia (Narrowleaf skullcap)	-	-	-	-	-	-	-	-	6
Senecio spp. (Groundsel, butterweed)	-	-	-	-	-	-	-	-	6
Tragopogon dubius (Yellow salsify)	10	-	0.10	-	-	-	-	-	22
Trifolium dubium (Suckling clover)	-	-	-	-	-	-	-	-	6
Unknown	5	-	0.08	0.05-0.15	-	-	-	-	28
Verbascum blattaria (Moth mullein)	-	-	-	-	-	-	-	-	6
Verbascum thapsus (Flannel mullein)	-	-	-	-	-	-	-	-	6
Vicia americana (American vetch)	5	-	0.10	-	-	-	-	-	6
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	646	-	2.29	-	21
Artemisia frigida (Fringed sagebrush)	-	-	-	-	-	-	-	-	5
Artemisia spp. (Sagebrush)	-	-	-	-	-	-	-	-	5
Artemisia tridentata (Big sagebrush)	28	10-75	11.86	2.00-35.00	1630	108-3658	0.93	0.50-1.69	74
Artemisia tripartita (Threetip sagebrush)	25	10-35	7.45	3.40-12.60	2098	1614-2582	0.35	0.25-0.44	26
Chrysothamnus nauseosus (Rubber rabbitbrush)	40	5-70	16.95	1.20-43.10	1556	215-8177	0.72	0.42-1.42	84

Table 24. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)[c]
Shrubs (cont.)									
Chrysothamnus viscidiflorus (Tall green rabbitbrush)	13	10-15	6.04	4.43-8.00	269	215-323	0.48	0.37-0.59	42
Crataegus columbiana (Columbia hawthorn)	-	-	-	-	-	-	-	-	5
Crataegus douglasii (Black hawthorn)	-	-	-	-	-	-	-	-	5
Eriogonum douglasii (Douglas buckwheat)	-	-	-	-	-	-	-	-	26
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	68
Grayia spinosa (Spiny hopsage)	30	-	9.26	-	1829	-	0.59	-	5
Leptodactylon pungens (Granitegilia)	-	-	-	-	592	430-753	0.26	0.24-0.28	32
Penstemon richardsonii (Penstemon)	-	-	-	-	-	-	-	-	5
Philadelphus lewisii (Mockorange)	-	-	-	-	-	-	-	-	5
Prunus virginiana (Common chokecherry)	10	-	3.70	-	-	-	-	-	11
Purshia tridentata (Antelope bitterbrush)	31	5-70	15.93	4.10-41.60	794	108-1506	0.99	0.61-1.86	74
Rhus glabra (Smooth sumac)	-	-	-	-	-	-	-	-	5
Rhus radicans (Poison ivy)	-	-	-	-	-	-	-	-	5
Ribes cereum (Wax currant)	-	-	-	-	-	-	-	-	5
Rosa gymnocarpa (Baldhip rose)	-	-	-	-	-	-	-	-	5
Rosa woodsii (Woods rose)	-	-	-	-	-	-	-	-	5
Salvia dorri (Purple sage)	-	-	-	-	861	-	0.40	-	11
Sambucus cerulea (Blue elderberry)	-	-	-	-	-	-	-	-	5
Symphoricarpos albus (Common snowberry)	-	-	-	-	-	-	-	-	5
Trees									
Juniperus occidentalis (Western juniper)	-	-	-	-	-	-	-	-	5
Pinus ponderosa (Ponderosa pine)	-	-	-	-	-	-	-	-	5
Populus trichocarpa (Black cottonwood)	-	-	-	-	-	-	-	-	5
Vegetation	60	25-100	2.22	0.75-5.35					
Litter	96	70-100	53.08	1.15-94.25					
Rock	11	0-90	4.83	0.00-60.90					
Erosion pavement	1	0-10	0.30	0.00-5.40					
Bare ground	66	5-100	42.51	3.95-98.00					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

[c]Because transect 18 was not sampled for grasses, grasslike plants, and forbs, it was omitted from calculation.

Table 25. Vegetation of the sagebrush transects (1, 7, 18, 20, 26, 28, 41, 43, 46) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Grasses									
Agropyron repens (Quackgrass)	15	-	0.20	-	-	-	-	-	13
Agropyron spicatum (Bluebunch wheatgrass)	50	-	2.30	-	-	-	-	-	75
Bromus inermis (Smooth brome)	-	-	-	-	-	-	-	-	13
Bromus japonicus (Japanese brome)	5	-	0.50	-	-	-	-	-	13
Bromus tectorum (Cheatgrass brome)	79	45-100	1.34	0.55-2.10	-	-	-	-	88
Elymus cinereus (Giant wildrye)	-	-	-	-	-	-	-	-	38
Festuca idahoensis (Idaho fescue)	15	-	1.25	-	-	-	-	-	13
Festuca microstachys (Small fescue)	35	-	0.35	-	-	-	-	-	13
Koelaria cristata (Prairie junegrass)	-	-	-	-	-	-	-	-	13
Oryzopsis hymenoides (Indian ricegrass)	5	-	0.05	-	-	-	-	-	25
Poa sandbergii (Sandberg bluegrass)	30	5-50	0.60	0.05-1.47	-	-	-	-	88
Stipa comata (Needle-and-thread)	12	5-25	0.54	0.05-1.20	-	-	-	-	75
Stipa richardsonii (Richardson needlegrass)	-	-	-	-	-	-	-	-	13
Forbs									
Achillea millefolium (Yarrow)	15	10-20	0.15	0.10-0.20	-	-	-	-	38
Agoseris spp. (Agoseris)	-	-	-	-	-	-	-	-	13
Allium cernuum (Nodding onion)	-	-	-	-	-	-	-	-	13
Antennaria rosea (Rose pussytoes)	-	-	-	-	-	-	-	-	13
Aster spp. (Aster)	10	-	0.20	-	-	-	-	-	13
Astragalus spp. (Milkvetch, locoweed)	-	-	-	-	-	-	-	-	13
Balsamorhiza sagittata (Arrowleaf balsamroot)	10	-	0.20	-	-	-	-	-	25
Brassica spp. (Mustard)	40	-	0.50	-	-	-	-	-	38
Brodiaea douglasii (Douglas brodiea)	-	-	-	-	-	-	-	-	25
Calochortus nuttallii (Segolily)	-	-	-	-	-	-	-	-	13
Castilleja spp. (Indian paintbrush)	10	-	0.10	-	-	-	-	-	25
Clematis ligusticifolia (Western virginsbower)	-	-	-	-	-	-	-	-	13
Cryptantha leucophaea	5	-	0.05	-	-	-	-	-	13
Cryptantha spp. (Cryptantha)	5	-	0.05	-	-	-	-	-	25
Cymopterus terebinthinus	-	-	-	-	-	-	-	-	13
Filago arvensis	5	-	0.05	-	-	-	-	-	38
Lepidium perfoliatum (Clasping pepperweed)	-	-	-	-	-	-	-	-	13
Lithospermum ruderale (Western gromwell)	-	-	-	-	-	-	-	-	13
Lomatium dissectum (Carrotleaf leptotaenia)	-	-	-	-	-	-	-	-	13
Lupinus spp. (Lupine)	-	-	-	-	-	-	-	-	25
Opuntia polycantha (Plains pricklypear)	5	-	0.50	-	-	-	-	-	13

Table 25. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Forbs (cont.)									
Orthocarpos luteus (Yellow owlclover)	-	-	-	-	-	-	-	-	13
Oxytropis spp. (Crazeweed)	-	-	-	-	-	-	-	-	13
Phacelia linearis (Threadleaf phacelia)	10	-	0.10	-	-	-	-	-	13
Rumex venosus (Veiny dock)	40	-	0.80	-	-	-	-	-	13
Senecio spp. (Groundsel, butterweed)	-	-	-	-	-	-	-	-	13
Tragopogon dubius (Yellow salsify)	-	-	-	-	-	-	-	-	25
Trifolium dubium (Suckling clover)	-	-	-	-	-	-	-	-	13
Unknown	-	-	-	-	-	-	-	-	13
Verbascum blattaria (Moth mullein)	-	-	-	-	-	-	-	-	13
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	-	-	-	-	22
Artemisia spp. (Sagebrush)	-	-	-	-	-	-	-	-	11
Artemisia tridentata (Big sagebrush)	40	10-75	19.04	5.40-35.00	2140	538-3658	0.91	0.50-1.69	100
Artemisia tripartita (Threetip sagebrush)	22	10-35	5.73	3.40-7.90	2098	1614-2582	0.35	0.25-0.44	44
Chrysothamnus nauseosus (Rubber rabbitbrush)	36	5-70	16.49	1.60-43.10	676	214-1614	0.61	0.42-0.86	89
Chrysothamnus viscidiflorus (Tall green rabbitbrush)	15	-	5.70	-	269	215-323	0.48	0.37-0.59	44
Crataegus douglasii (Black hawthorn)	-	-	-	-	-	-	-	-	11
Eriogonum douglasii (Douglas buckwheat)	-	-	-	-	-	-	-	-	33
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	56
Leptodactylon pungens (Granitegilia)	-	-	-	-	430	-	0.28	-	22
Penstemon richardsonii (Penstemon)	-	-	-	-	-	-	-	-	11
Philadelphus lewisii (Mockorange)	-	-	-	-	-	-	-	-	11
Purshia tridentata (Antelope bitterbrush)	10	5-15	7.30	4.10-10.50	861	430-1291	0.87	0.86-0.88	56
Rhus glabra (Smooth sumac)	-	-	-	-	-	-	-	-	11
Ribes cereum (Wax currant)	-	-	-	-	-	-	-	-	11
Rosa woodsii (Woods rose)	-	-	-	-	-	-	-	-	11
Salvia dorri (Purple sage)	-	-	-	-	-	-	-	-	11
Sambucus cerulea (Blue elderberry)	-	-	-	-	-	-	-	-	11
Trees									
Populus trichocarpa (Black cottonwood)	-	-	-	-	-	-	-	-	11

Table 25. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied (%)[c]
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Vegetation	61	25-100	2.46	0.75-5.35					
Litter	96	85-100	61.30	37.90-92.97					
Rock	6	0-20	2.39	0.00-14.80					
Erosion pavement	0	-	0.00	-					
Bare ground	68	35-90	41.51	5.15-98.00					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

[c]Because transect 18 was not sampled for grasses, grasslike plants, and forbs, it was omitted from calculation.

Table 26. Vegetation of the bitterbrush transects (19, 32, 45) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	25	-	0.22	-	-	-	-	-	67
Agrostis spica-venti (Bentgrass)	10	-	0.15	-	-	-	-	-	33
Bromus tectorum (Cheatgrass brome)	55	-	1.00	-	-	-	-	-	33
Oryzopsis hymenoides (Indian ricegrass)	5	-	0.05	-	-	-	-	-	67
Poa bulbosa (Bulbous bluegrass)	-	-	-	-	-	-	-	-	33
Stipa comata (Needle-and-thread)	18	5-30	0.29	0.10-0.47	-	-	-	-	67
Unknown	15	-	0.32	-	-	-	-	-	33
Forbs									
Achillea millefolium (Yarrow)	-	-	-	-	-	-	-	-	33
Agoseris spp. (Agoseris)	-	-	-	-	-	-	-	-	33
Aster spp. (Aster)	-	-	-	-	-	-	-	-	33
Brassica spp. (Mustard)	5	-	0.30	-	-	-	-	-	33
Cerastium arvense (Starry cerastium)	-	-	-	-	-	-	-	-	33
Cryptantha leucophaea	5	-	0.05	-	-	-	-	-	33
Filago arvensis	-	-	-	-	-	-	-	-	33
Oenothera pallida (Pale eveningprimrose)	15	-	0.12	-	-	-	-	-	33
Phacelia linearis (Threadleaf phacelia)	-	-	-	-	-	-	-	-	33
Scutellaria angustifolia (Narrowleaf skullcap)	-	-	-	-	-	-	-	-	33
Unknown	5	-	0.15	-	-	-	-	-	33
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	646	-	2.29	-	33
Artemisia frigida (Fringed sagebrush)	-	-	-	-	-	-	-	-	33
Artemisia tridentata (Big sagebrush)	15	-	2.00	-	108	-	1.01	-	33
Artemisia tripartita (Threetip sagebrush)	30	-	12.60	-	-	-	-	-	33
Chrysothamnus nauseosus (Rubber rabbitbrush)	-	-	-	-	-	-	-	-	33
Eriogonum douglasii (Douglas buckwheat)	-	-	-	-	-	-	-	-	33
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	100
Leptodactylon pungens (Granitegilia)	-	-	-	-	-	-	-	-	67
Prunus virginiana (Common chokecherry)	10	-	3.70	-	-	-	-	-	33
Purshia tridentata (Antelope bitterbrush)	48	35-60	24.70	16.40-33.00	1112	861-1506	0.98	0.88-1.04	100
Trees									
Juniperus occidentalis (Western juniper)	-	-	-	-	-	-	-	-	33
Pinus ponderosa (Ponderosa pine)	-	-	-	-	-	-	-	-	33

Table 26. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Vegetation	57	50-70	2.17	1.00-4.40					
Litter	87	70-100	22.42	1.15-33.25					
Rock	32	0-90	20.80	0.00-60.90					
Erosion pavement	0	-	0.00	-					
Bare ground	62	5-100	54.62	4.75-96.35					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 27. Vegetation of the rabbitbrush transects (4, 49, 53, 55) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron cristatum (Fairway crested wheatgrass)	30	-	0.27	-	-	-	-	-	25
Agropyron spicatum (Bluebunch wheatgrass)	-	-	-	-	-	-	-	-	75
Agrostis alba (Redtop)	-	-	-	-	-	-	-	-	25
Bromus brizaeformis (Rattle brome)	-	-	-	-	-	-	-	-	25
Bromus japonicus (Japanese brome)	58	25-90	0.70	0.27-1.12	-	-	-	-	75
Bromus tectorum (Cheatgrass brome)	61	15-100	1.32	0.15-2.65	-	-	-	-	100
Poa bulbosa (Bulbous bluegrass)	-	-	-	-	-	-	-	-	25
Poa sandbergii (Sandberg bluegrass)	13	10-15	0.15	-	-	-	-	-	50
Stipa comata (Needle-and-thread)	-	-	-	-	-	-	-	-	25
Stipa viridula (Green needlegrass)	-	-	-	-	-	-	-	-	25
Forbs									
Achillea millefolium (Yarrow)	5	-	0.05	-	-	-	-	-	75
Balsamorhiza sagittata (Arrowleaf balsamroot)	-	-	-	-	-	-	-	-	50
Brassica spp. (Mustard)	20	-	0.30	-	-	-	-	-	25
Brodiaea douglasii (Douglas brodiea)	-	-	-	-	-	-	-	-	25
Centaurea diffusa	5	-	0.05	-	-	-	-	-	25
Centaurium spp. (Centaurium)	-	-	-	-	-	-	-	-	25
Cerastium arvense (Starry cerastium)	40	-	0.45	-	-	-	-	-	25
Clematis ligusticifolia (Western virginsbower)	-	-	-	-	-	-	-	-	25
Erigeron spp. (Fleabane, daisy)	5	-	0.02	-	-	-	-	-	25
Filago arvensis	-	-	-	-	-	-	-	-	25
Galium boreale (Northern bedstraw)	-	-	-	-	-	-	-	-	25
Lepidium perfoliatum (Clasping pepperweed)	-	-	-	-	-	-	-	-	50
Lithospermum ruderale (Western gromwell)	-	-	-	-	-	-	-	-	25
Lomatium spp. (Biscuitroot, lomatium)	-	-	-	-	-	-	-	-	50
Lupinus spp. (Lupine)	-	-	-	-	-	-	-	-	50
Medicago sativa (Alfalfa)	-	-	-	-	-	-	-	-	25
Opuntia polycantha (Plains pricklypear)	-	-	-	-	-	-	-	-	50
Tragopogon dubius (Yellow salsify)	10	-	0.10	-	-	-	-	-	50
Unknown	5	-	0.05	-	-	-	-	-	50
Verbascum thapsus (Flannel mullein)	-	-	-	-	-	-	-	-	25
Vicia americana (American vetch)	5	-	0.10	-	-	-	-	-	50
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	-	-	-	-	-	-	-	-	25
Artemisia tridentata (Big sagebrush)	20	-	7.45	-	-	-	-	-	25
Chrysothamnus nauseosus (Rubber rabbitbrush)	52	45-60	19.76	14.90-26.20	3712	1506-8177	0.76	0.45-1.21	100

Table 27. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Shrubs (cont.)									
Chrysothamnus viscidiflorus (Tall green rabbitbrush)	15	-	8.00	-	-	-	-	-	75
Crataegus columbiana (Columbia hawthorn)	-	-	-	-	-	-	-	-	25
Eriogonum douglasii (Douglas buckwheat)	-	-	-	-	-	-	-	-	25
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	75
Prunus virginiana (Common chokecherry)	-	-	-	-	-	-	-	-	25
Purshia tridentata (Antelope bitterbrush)	45	20-70	24.45	7.30-41.60	1076	-	1.86	-	75
Rhus radicans (Poison ivy)	-	-	-	-	-	-	-	-	25
Rosa gymnocarpa (Baldhip rose)	-	-	-	-	-	-	-	-	25
Symphoricarpos albus (Common snowberry)	-	-	-	-	-	-	-	-	25
Vegetation	68	30-100	2.29	1.05-4.60					
Litter	100	-	73.59	39.25-94.25					
Rock	0	-	0.00	-					
Erosion pavement	0	-	0.00	-					
Bare ground	46	5-95	24.13	3.95-59.70					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 28. Vegetation of the shrub steppe transects *Grayia spinosa* (13), *Leptodactylon pungens* (31) and *Salvia dorri* (37) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron spicatum (Bluebunch wheatgrass)	5	-	0.15	-	-	-	-	-	33
Bromus tectorum (Cheatgrass brome)	37	5-60	0.45	0.05-0.80	-	-	-	-	100
Festuca microstachys (Small fescue)	10	-	0.10	-	-	-	-	-	33
Oryzopsis hymenoides (Indian ricegrass)	-	-	-	-	-	-	-	-	100
Poa sandbergii (Sandberg bluegrass)	8	5-10	0.17	0.05-0.25	-	-	-	-	100
Stipa comata (Needle-and-thread)	-	-	-	-	-	-	-	-	67
Unknown	5	-	0.05	-	-	-	-	-	33
Forbs									
Achillea millefolium (Yarrow)	5	-	0.05	-	-	-	-	-	33
Balsamorhiza sagittata (Arrowleaf balsomroot)	-	-	-	-	-	-	-	-	33
Brassica spp. (Mustard)	-	-	-	-	-	-	-	-	33
Brodiaea douglasii (Douglas brodiea)	-	-	-	-	-	-	-	-	33
Centaurea spp. (Centaurea, knapweed)	-	-	-	-	-	-	-	-	33
Cryptantha leucophaea	10	-	0.10	-	-	-	-	-	33
Cymopterus terebinthinus	10	-	0.55	-	-	-	-	-	33
Filago arvensis	15	-	0.15	-	-	-	-	-	67
Oenothera pallida (Pale eveningprimrose)	-	-	-	-	-	-	-	-	33
Opuntia polycantha (Plains pricklypear)	-	-	-	-	-	-	-	-	33
Orobanche uniflora minuta (Naked broomrape)	-	-	-	-	-	-	-	-	33
Phacelia linearis (Threadleaf phacelia)	5	-	0.05	-	-	-	-	-	67
Salsola kali tenuifolia (Russianthistle)	-	-	-	-	-	-	-	-	33
Unknown	5	0.05	-	-	-	-	-	-	33
Shrubs									
Artemisia tridentata (Big sagebrush)	13	10-15	4.64	3.63-6.10	610	323-861	0.98	0.56-1.68	100
Chrysothamnus nauseosus (Rubber rabbitbrush)	33	5-60	13.90	1.20-26.60	323	215-430	1.06	0.69-1.42	100
Chrysothamnus viscidiflorus (Tall green rabbitbrush)	10	-	4.43	-	-	-	-	-	33
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	67
Grayia spinosa (Spring hopsage)	30	-	9.26	-	1829	-	0.59	-	33
Leptodactylon pungens (Granitegilia)	-	-	-	-	753	-	0.24	-	67
Purshia tridentata (Antelope bitterbrush)	20	-	7.25	4.30-10.20	108	-	0.69	0.61-0.76	100
Salvia dorri (Purple sage)	-	-	-	-	861	-	0.40	-	33

Table 28. Cont.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Vegetation	50	45-55	1.57	1.40-1.70					
Litter	97	90-100	37.27	22.65-60.30					
Rock	17	0-50	1.82	0.00-5.45					
Erosion pavement	3	0-10	1.80	0.00-5.40					
Bare ground	92	80-100	57.55	38.30-70.20					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

10 on the rabbitbrush transects, and 7 on the other shrub steppe transects. No grasslike plants were recorded.

Altogether, 44 species of forbs were recorded, of which not one occurred on more than 44% of the transects. Twenty-two occurred individually on only one transect. Thirty species occurred on the sagebrush transects, 11 on the bitterbrush, 21 on the rabbitbrush, and 14 on the other shrub steppe transects.

Altogether, 25 species of shrubs were recorded, of which rubber rabbitbrush appeared on 84% of the transects, big sagebrush and bitterbrush each occurred on 74% of the transects, and snow eriogonum occurred on 68% of the transects. Fourteen (56%) each occurred on only one transect. Only nine species were abundant enough to be measured.

Three species of tree were recorded on one transect each, but in insufficient abundance to be measured.

In total, live vegetation occurred in a frequency of 60%, compared to 96% for litter and 66% for bare ground. Basal coverage averaged 2% for live vegetation, 53% for litter, 5% for rock, and 43% for bare ground.

Sand dune (Table 29)

The dunes represent an actively moving substrate, and plant composition and densities change during short periods of time. Sand dunes were located in the southern part of the study area -- Hanford, Priest Rapids, and Wanapum. Two transects were established, one in the Hanford segment and one in the Wanapum segment. Because the Wanapum transect contained a substantial amount of bitterbrush, this transect was also included in the discussion on shrub steppe.

Three species of grass were recorded, of which quackgrass and Indian ricegrass occurred on both transects, with a frequency of 15% and 8%, and ground cover of 0.14% and 0.08%, respectively. Cheatgrass occurred on one transect, but in insufficient abundance to be measured. No grasslike plants occurred.

At last six species of forb occurred, of which only pale eveningprimrose occurred sparsely on both transects.

Four species of shrub were recorded, of which rubber rabbitbrush and snow eriogonum occurred of both transects, but in insufficient quantity to be measured. Bitterbrush occurred on one transect in a density of 968 stems per ha. No trees occurred.

Live vegetation occurred in a frequency of 48% compared to 60% for litter and 100% for bare ground. The basal coverage was 1% for live vegetation, 1% for litter, 1% for rock, and 97% for bare ground.

Table 29. Vegetation of the sand dune transects (3, 19) along the upper Columbia River.

Species[a]	Percent frequency		Percent ground cover[b]		Shrubs & Trees per ha		Shrub & Tree height (m)		Transects occupied
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	(%)
Grasses									
Agropyron repens (Quackgrass)	15	5-25	0.14	0.05-0.22	-	-	-	-	100
Bromus tectorum (Cheatgrass brome)	-	-	-	-	-	-	-	-	50
Oryzopsis hymenoides (Indian ricegrass)	8	5-10	0.08	0.05-0.10	-	-	-	-	100
Forbs									
Cryptantha leucophaea	5	-	0.05	-	-	-	-	-	50
Erysimum spp. (Wallflower)	-	-	-	-	-	-	-	-	50
Medicago sativa (Alfalfa)	5	-	0.05	-	-	-	-	-	50
Oenothera pallida (Pale eveningprimrose)	15	-	0.12	-	-	-	-	-	100
Rumex venosus (Veiny dock)	10	-	0.15	-	-	-	-	-	50
Unknown	5	-	0.10	0.05-0.15	-	-	-	-	100
Shrubs									
Artemisia tridentata (Big sagebrush)	-	-	-	-	-	-	-	-	50
Chrysothamnus nauseosus (Rubber rabbitbrush)	-	-	-	-	-	-	-	-	100
Eriogonum niveum (Snow eriogonum)	-	-	-	-	-	-	-	-	100
Purshia tridentata (Antelope bitterbrush)	-	-	-	-	968	-	1.04	-	50
Vegetation	48	25-70	0.65	0.30-1.00					
Litter	60	50-70	0.90	0.65-1.15					
Rock	3	0-5	0.75	0.00-1.50					
Erosion pavement	0	-	0.00	-					
Bare ground	100	-	97.85	96.35-99.35					

[a]Species listed without values indicate they were present on the transect, but not sampled.

[b]For shrubs and trees, percent crown cover is used, except for total vegetation, where percent basal coverage is used.

Table 30. Comparison of percent frequency and percent basal coverage for the general habitat types sampled along the upper Columbia River.

Habitat	Live vegetation		Litter		Rock		Erosion pavement		Bare ground	
	Frequency	Cover	Frequency	Cover	Frequency	Cover	Frequency	Cover	Frequency	Cover
Riparian shrub	96	2	86	68	16	3	0	0	46	27
Riparian tree	70	1	97	84	3	1	0	0	26	14
Equisetum	100	1	100	95	0	0	0	0	40	4
Grassland	80	22	90	69	0	0	0	0	40	9
Cobble & gravel	83	2	65	16	82	71	0	0	27	11
Conifer	57	2	98	74	15	3	0	0	45	21
Shrub steppe	60	2	96	53	11	4	1	1	66	42
Sand dune	48	1	60	1	3	1	0	0	100	97

Table 31. Vegetation of the upper Columbia River.

Segment 1. Hanford.
Transects 1, 2, 3, 4, 6, 7, 8, 9, 71, 72

Grasses	
Agropyron repens	Quackgrass
Agropyron spicatum	Bluebunch wheatgrass
Bromus tectorum	Cheatgrass brome
Elymus cinereus	Giant wildrye
Festuca microstachys	Small fescue
Oryzopsis hymenoides	Indian ricegrass
Poa sandbergii	Sandberg bluegrass
Stipa comata	Needle-and-thread
Forbs	
Achillea millefolium	Yarrow
Ascelepias speciosa	Showy milkweed
Brassica spp.	Mustard
Brodiaea douglasii	Douglas brodiea
Centaurea spp.	Centaurea, knapweed
Centaurium spp.	Centaurium
Cerastium arvense	Starry cerastium
Cryptantha spp.	Cryptantha
Cryptogramma spp.	Rockbrake
Equisetum hyemale	Western scouringrush
Eriogonum compositum	Northern buckwheat
Erysimum spp.	Wallflower
Lepidium perfoliatum	Clasping pepperweed
Lupinus spp.	Lupine
Oenothera pallida	Pale eveningprimrose
Plantago patogonica	Indianwheat
Rumex venosus	Veiny dock
Salsola kali tenuifolia	Russianthistle
Verbascum blatteria	Moth mullein
Unknown	
Shrubs	
Artemisia tridentata	Big sagebrush
Artemisia tripartita	Threetip sagebrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Tall green rabbitbrush
Eriogonum niveum	Snow eriogonum
Prunus virginiana	Common chokecherry
Purshia tridentata	Antelope bitterbrush
Ribes cereum	Wax currant
Rosa woodsii	Woods rose
Salix exigua	Coyote willow
Trees	
Populus trichocarpa	Black cottonwood

Table 32. Vegetation of the upper Columbia River.

Segment 2. Priest Rapids.
Transects 11, 12, 13

Grasses	
Agropyron repens	Quackgrass
Bromus tectorum	Cheatgrass brome
Festuca microstachys	Small fescue
Koeleria cristata	Prairie junegrass
Oryzopsis hymenoides	Indian ricegrass
Phalaris arundinacea	Reed canarygrass
Poa compressa	Canada bluegrass
Poa sandbergii	Sandberg bluegrass
Unknown	
Grasslike plants	
Carex spp.	Sedge
Juncus balticus	Baltic rush
Forbs	
Artemisia lindleyana	
Cryptantha leucophaea	
Equisetum hyemale	Western scouringrush
Lupinus polyphyllus	Bigleaf lupine
Salsola kali tenuifolia	Russianthistle
Unknown	
Shrubs	
Artemisia tridentata	Big sagebrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Tall green rabbitbrush
Eleagnus angustifolia	Russian olive
Grayia spinosa	Spiny hopsage
Purshia tridentata	Antelope bitterbrush
Salix amygdaloides	Peachleaf willow
Salix exigua	Coyote willow
Trees	
Populus trichocarpa	Black cottonwood

Table 33. Vegetation of the upper Columbia River.

Segment 3. Wanapum.
Transects 18, 19, 20, 21

Grasses	
Agropyron repens	Quackgrass
Agropyron spicatum	Bluebunch wheatgrass
Bromus tectorum	Cheatgrass brome
Festuca microstachys	Small fescue
Oryzopsis hymenoides	Indian ricegrass
Poa sandbergii	Sandberg bluegrass
Stipa comata	Needle-and-thread
Grasslike plants	
Scirpus acutus	Tule bulrush
Forbs	
Agoseris spp.	Agoseris
Balsamorhiza sagittata	Arrowleaf balsamroot
Brodiaea douglasii	Douglas brodiea
Cryptantha leucophaea	
Oenothera pallida	Pale eveningprimrose
Rumex venosus	Veiny dock
Trifolium dubium	Suckling clover
Typha latifolia	Common cattail
Unknown	
Shrubs	
Artemisia tridentata	Big sagebrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Tall green rabbitbrush
Eriogonum niveum	Snow eriogonum
Purshia tridentata	Antelope bitterbrush
Salix exigua	Coyote willow

Table 34. Vegetation of the upper Columbia River.

Segment 4. Rock Island.
Transects 24, 25, 26, 27

Grasses	
Agropyron repens	Quackgrass
Bromus tectorum	Cheatgrass brome
Phalaris arundinacea	Reed canarygrass
Poa juncifolia	Alkali bluegrass
Forbs	
Asparagus officinalis	Garden asparagus
Asclepias speciosa	Showy milkweed
Brassica spp.	Mustard
Centaurea spp.	Centaurea, knapweed
Epilobium angustifolium	Fireweed
Equisetum hymemale	Western scouringrush
Solanum dulcamara	Bitter nightshade
Urtica dioica	Big stinging nettle
Verbascum thapsus	Flannel mullein
Unknown	
Shrubs	
Amelanchier alnifolia	Saskatoon serviceberry
Artemisia tridentata	Big sagebrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Crataegus columbiana	Columbia hawthorn
Eriogonum niveum	Snow eriogonum
Morus rubra	Red mulberry
Penstemon richardsonii	Penstemon
Rhus glabra	Smooth sumac
Rhus radicans	Poison ivy
Rosa acicularis	Prickly rose
Rosa woodsii	Woods rose
Salix exigua	Coyote willow
Salix spp.	Willow
Salvia dorri	Purple sage
Sambucus cerulea	Blue elderberry
Trees	
Acer negundo	Boxelder
Populus trichocarpa	Black cottonwood

Table 35. Vegetation of the upper Columbia River.
Segment 5. Rocky Reach.
Transects 28, 29, 31, 32, 33, 69, 70

Grasses	
Agropyron repens	Quackgrass
Agropyron spicatum	Bluebunch wheatgrass
Bromus tectorum	Cheatgrass brome
Oryzopsis hymenoides	Indian ricegrass
Poa bulbosa	Bulbous bluegrass
Poa sandbergii	Sandberg bluegrass
Stipa comata	Needle-and-thread
Forbs	
Achillea millefolium	Yarrow
Aster spp.	Aster
Balsamorhiza sagittata	Arrowleaf balsamroot
Brassica spp.	Mustard
Centaurea spp.	Centaurea, knapweed
Cryptantha leucophaea	
Filago arvensis	
Lepidium perfoliatum	Clasping pepperweed
Lupinus spp.	Lupine
Oenothera pallida	Pale eveningprimrose
Opuntia polycantha	Plains pricklypear
Phacelia linearis	Threadleaf phacelia
Purshia tridentata	Antelope bitterbrush
Tragopogon dubius	Yellow salsify
Unknown	
Shrubs	
Alnus sinuata	Sitka alder, mountain alder
Amelanchier alnifolia	Saskatoon serviceberry
Artemisia tridentata	Big sagebrush
Artemisia tripartita	Threetip sagebrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Tall green rabbitbrush
Cornus stolonifera	Red-osier dogwood
Eleagnus angustifolia	Russian olive
Eriogonum niveum	Snow eriogonum
Leptodactylon pungens	Granitegilia
Morus rubra	Red mulberry
Purshia tridentata	Antelope bitterbrush
Rosa acicularis	Prickly rose
Salix amygdaloides	Peachleaf willow
Salix exigua	Coyote willow
Trees	
Juniperus occidentalis	Western juniper

Table 36. Vegetation of the upper Columbia River.

Segment 6. Wells.
Transects 35, 36, 37, 38, and 40

Grasses	
Agropyron repens	Quackgrass
Agropyron spicatum	Bluebunch wheatgrass
Bromus tectorum	Cheatgrass brome
Dactylis glomerata	Orchardgrass
Oryzopsis hymenoides	Indian ricegrass
Phalaris arundinacea	Reed canarygrass
Poa compressa	Canada bluegrass
Poa sandbergii	Sandberg bluegrass
Stipa comata	Needle-and-thread
Grasslike plants	
Carex spp.	Sedge
Scirpus acutus	Tule bulrush
Forbs	
Achillea millefolium	Yarrow
Asparagus officinalis	Garden asparagus
Aster spp.	Aster
Balsamorhiza sagittata	Arrowleaf balsamroot
Brodiaea douglasii	Douglas brodiea
Cirsium arvense	Canada thistle
Clematis ligusticifolia	Western virginsbower
Cymopterus terebinthinus	
Equisetum hyemale	Western scouringrush
Filago arvensis	
Mentha spp.	Mint
Orobanche uniflora minuta	Naked broomrape
Phacelia linearis	Threadleaf phacelia
Plantago patogonica	Indianwheat
Rumex spp.	Dock, sorrel
Scutellaria angustifolia	Narrowleaf skullcap
Taraxacum officinale	Common dandelion
Tragopogon dubius	Yellow salsify
Typha latifolia	Common cattail
Unknown	
Shrubs	
Artemisia tridentata	Big sagebrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Eriogonum niveum	Snow eriogonum
Leptodactylon pungens	Granitegilia
Morus rubra	Red mulberry
Prunus virginiana	Common chokecherry
Purshia tridentata	Antelope bitterbrush
Rhus radicans	Poison ivy

Table 36.

Shrubs (cont.)	
Rosa acicularis	Prickly rose
Salix amydaloides	Peachleaf willow
Salix exigua	Coyote willow
Salix spp.	Willow
Salvia dorri	Purple sage
Trees	
Populus trichocarpa	Black cottonwood

Table 37. Vegetation of the upper Columbia River.

Segment 7. Rufus Woods Lake
Transects 41, 43, 44, 45, 46, 47

Grasses	
Agropyron repens	Quackgrass
Agropyron spicatum	Bluebunch wheatgrass
Agrostis spica-venti	Bentgrass
Bromus inermis	Smooth brome
Bromus japonicus	Japanese brome
Bromus tectorum	Cheatgrass brome
Elymus cinereus	Giant wildrye
Festuca idahoensis	Idaho fescue
Koeleria cristata	Prairie junegrass
Oryzopsis hymenoides	Indian ricegrass
Poa compressa	Canada bluegrass
Poa sandbergii	Sandberg bluegrass
Stipa comata	Needle-and-thread
Stipa richardsonii	Richardson needlegrass
Unknown	
Grasslike plants	
Juncus balticus	Baltic rush
Forbs	
Achillea millefolium	Yarrow
Agoseris spp.	Agoseris
Allium cernuum	Nodding onion
Antennaria rosea	Rose pussytoes
Aster spp.	Aster
Astragalus spp.	Milkvetch, locoweed
Balsamorhiza sagittata	Arrowleaf balsamroot
Brodiaea douglasii	Douglas brodiea
Calochortus nuttallii	Segolily
Castilleja spp.	Indian paintbrush
Cerastium arvense	Starry cerastium
Clarkia pulchella	Elkhorns clarkia
Clematis ligusticifolia	Western virginsbower
Cryptantha spp.	Cryptantha
Cymopterus terebinthinus	
Equisetum hyemale	Western scouringrush
Erodium cicutarium	Storksbill
Filago arvensis	
Galium boreale	Northern bedstraw
Hackelia floribunda	Showy stickseed
Lepidium perfoliatum	Clasping pepperweed
Lithospermum ruderale	Western gromwell
Lomatium dissectum	Carrotleaf leptotaenia
Lupinus spp.	Lupine
Opuntia polycantha	Plains pricklypear
Orthocarpus luteus	Yellow owlclover

Table 37.

Forbs (cont.)	
Oxytropis spp.	Crazeweed
Phacelia linearis	Threadleaf phacelia
Scutellaria angustifolia	Narrowleaf skullcap
Sedum stenopetalum	Wormleaf stonecrop
Senecio spp.	Groundsel, butterweed
Stanleya confertiflora	Princesplume
Tragopogon dubius	Yellow salsify
Tragopogon spp.	Salsify
Verbascum thapsus	Flannel mullein
Shrubs	
Amelanchier alnifolia	Saskatoon serviceberry
Artemisia spp.	Sagebrush
Artemisia tridentata	Big sagebrush
Artemisia tripartita	Threetip sagebrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Tall green rabbitbrush
Crataegus columbiana	Columbia hawthorn
Crataegus douglasii	Black hawthorn
Eriogonum douglasii	Douglas buckwheat
Eriogonum niveum	Snow eriogonum
Leptodactylon pugens	Granitegilia
Philadelphus lewisii	Mockorange
Prunus virginiana	Common chokecherry
Purshia tridentata	Antelope bitterbrush
Rhus glabra	Smooth sumac
Rosa acicularis	Prickly rose
Rosa gymnocarpa	Baldhip rose
Rosa woodsii	Woods rose
Trees	
Betula occidentalis	Water birch
Juniperus occidentalis	Western juniper
Pinus ponderosa	Ponderosa pine

Table 38. Vegetation of the upper Columbia River.

Segment 8. South FDR
Transects 49, 50, 51, 58, 54, 55

Grasses	
Agropyron cristatum	Fairway crested wheatgrass
Agropyron spicatum	Bluebunch wheatgrass
Agrostis alba	Redtop
Bromus brizaeformis	Rattle brome
Bromus inermis	Smooth brome
Bromus japonicus	Japanese brome
Bromus tectorum	Cheatgrass brome
Festuca idahoensis	Idaho fescue
Festuca occidentalis	Western fescue
Koeleria cristata	Prairie junegrass
Poa bulbosa	Bulbous bluegrass
Poa juncifolia	Alkali bluegrass
Poa sandbergii	Sandberg bluegrass
Stipa comata	Needle-and-thread
Stipa richardsonii	Richardson needlegrass
Stipa viridula	Green needlegrass
Forbs	
Achillea millefolium	Yarrow
Agoseris spp.	Agoseris
Antennaria rosea	Rose pussytoes
Aster spp.	Aster
Astragalus spp.	Milkvetch, locoweed
Balsamorhiza sagitta	Arrowleaf balsamroot
Besseya rubra	Kittentails
Brodiaea douglasii	Douglas brodiea
Centaurea diffusa	Centaurea
Clarkia pulchella	Elkhorns clarkia
Clematis ligusticifolia	Western virginsbower
Collomia linearis	Narrowleaf collomia
Cryptantha spp.	Cryptantha
Cymopteris terebinthinus	Cymopteris
Erigeron spp.	Fleabane, daisy
Filago arvensis	
Galium boreale	Northern bedstraw
Geum triflorum	Prairiesmoke avens
Lepidium perfoliatum	Clasping pepperweed
Lithospermum ruderale	Western gromwell
Lomatium spp.	Biscuitroot, lomatium
Lupinus spp.	Lupine
Medicago sativa	Alfalfa
Montia spp.	Indianlettuce
Opuntia polycantha	Plains pricklypear
Phacelia linearis	Threadleaf phacelia
Rudbeckia hirta	Blackeyedsusan
Scutellaria angustifolia	Narrowleaf skullcap

Table 38.

Forbs (cont.)	
Tragopogon dubius	Yellow salsify
Verbascum thapsus	Flannel mullein
Vicia americana	American vetch
Unknown	
Shrubs	
Acer glabrum	Rockymountain maple
Amelanchier alnifolia	Saskatoon serviceberry
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Tall green rabbitbrush
Crataegus columbiana	Columbia hawthorn
Eriogonum douglasii	Douglas buckwheat
Eriogonum niveum	Snow eriogonum
Holodiscus discolor	Creambush oceanspray
Leptodactylon pungens	Granitegilia
Philadelphus lewisii	Mockorange
Prunus virginiana	Common chokecherry
Purshia tridentata	Antelope bitterbrush
Rhus glabra	Smooth sumac
Rhus radicans	Poison ivy
Ribes cereum	Wax currant
Rosa gymnocarpa	Baldhip rose
Salvia dorri	Purple sage
Sambucus cerulea	Blue elderberry
Spiraea douglasii	Douglas spirea
Symphoricarpos albus	Common snowberry
Trees	
Pinus ponderosa	Ponderosa pine
Psuedotsuga menziesii	Douglas-fir

Table 39. Vegetation of the upper Columbia River.

Segment 9. North FDR
Transects 56, 57, 58, 59, 60, 61, 68

Grasses	
Agropyron spicatum	Bluebunch wheatgrass
Bromus japonicus	Japanese brome
Bromus tectorum	Cheatgrass brome
Calamagrostis rubescens	Pinegrass
Elymus cinereus	Giant wildrye
Festuca occidentalis	Western fescue
Koeleria cristata	Prairie junegrass
Phalaris arundinacea	Reed canarygrass
Poa compressa	Canada bluegrass
Stipa richardsonii	Richardson needlegrass
Grasslike plants	
Carex geyeri	Elk sedge
Forbs	
Achillea millefolium	Yarrow
Antennaria rosea	Rose pussytoes
Apocynum androsaemifolium	Spreading dogbane
Balsamorhiza sagittata	Arrowleaf balsamroot
Besseya rubra	Kittentails
Centaurea spp.	Centaurea, knapweed
Clarkia pulchella	Elkhorns clarkia
Collomia linearis	Narrowleaf collomia
Disporum trachycarpum	Wartberry fairybells
Erigeron subtrinervis	Threenerve fleabane
Filago arvensis	
Fragaria vesca	Woods strawberry
Galium boreale	Northern bedstraw
Gilia aggregata	Skyrocket gilia
Heuchera spp.	Alumroot
Lewisia rediviva	Bitterroot lewisia
Lithospermum ruderale	Western gromwell
Lupinus spp.	Lupine
Montia spp.	Indianlettuce
Phacelia linearis	Threadleaf phacelia
Plantago patogonica	Indianwheat
Pterospora andromedea	Woodland pinedrops
Rumex xpp.	Dock, sorrel
Scutellaria angustifolia	Narrowleaf skullcap
Smilacina racemosa	Feather solomonplume
Smilacina stellata	Starry solomonplume
Solanum dulcamara	Bitter nightshade
Tragopogon dubius	Yellow salsify
Urtica dioica	Big stinging nettle
Verbascum blattaria	Moth mullein
Vicia americana	American vetch
Unknown	

Table 39. Cont.

Shrubs	
Acer glabrum	Rockymountain maple
Alnus sinuata	Sitka alder, mountain alder
Amelanchier alnifolia	Saskatoon serviceberry
Arctostaphylos uva-ursi	Bearberry
Berberis repens	Low oregongrape
Chrysothamnus nauseosus	Rubber rabbitbrush
Cornus stolonifera	Red-osier dogwood
Corylus cornuta	
Crataegus columbiana	Columbia hawthorn
Crataegus douglasii	Black hawthorn
Eriogonum douglasii	Douglas buckwheat
Eriogonum niveum	Snow eriogonum
Holodiscus discolor	Creambush oceanspray
Pachistima myrsinites	Pachistima, Mt. lover
Philadelphus lewisii	Mockorange
Prunus virginiana	Common chokecherry
Purshia tridentata	Antelope bitterbrush
Rhus radicans	Poison ivy
Rosa spp.	Rose
Rosa woodsii	Woods rose
Spiraea douglasii	Douglas spirea
Symphoricarpos albus	Common snowberry
Unknown	
Trees	
Betula occidentalis	Water birch
Betula papyrifera	Paper birch
Juniperus occidentalis	Western juniper
Larix occidentalis	Western larch
Pinus ponderosa	Ponderosa pine
Pseudotsuga menziesii	Douglas-fir
Pyrus malus	Apple
Thuja plicata	Western redcedar

Table 40. Vegetation of the upper Columbia River.
Segment 10. British Columbia
Transects 62, 63, 64, 65, 66, 67

Grasses	
Agropyron repens	Quackgrass
Agrostis alba	Redtop
Bromus tectorum	Cheatgrass brome
Danthonia spicata	Poverty oatgrass
Elymus glaucus	Blue wildrye
Koeleria cristata	Prairie junegrass
Phleum pratense	Timothy
Poa compressa	Canada bluegrass
Stipa comata	Needle-and-thread
Stipa spartea	Porcupine grass
Unknown	
Forbs	
Achillea millefolium	Yarrow
Allium cernuum	Nodding onion
Asparagus officinalis	Garden asparagus
Companula rotundifolia	American bellflower
Centaurea spp.	Centaurea, knapweed
Equisetum hyemale	Western scouringrush
Fragaria vesca	Woods strawberry
Galium boreale	Northern bedstraw
Gilia aggregata	Skyrocket gilia
Lupinus spp.	Lupine
Prunella vulgaris	Common selfheal
Rumex spp.	Dock, sorrel
Smilacina stellata	Starry solomonplume
Solanum dulcamara	Bitter nightshade
Taraxacum officinale	Common dandelion
Tragopogon dubius	Yellow salsify
Verbascum thapsus	Flannel mullein
Vicia americana	American vetch
Unknown	
Shrubs	
Acer glabrum	Rockymountain maple
Alnus sinuata	Sitka alder, mountain alder
Amelanchier alnifolnia	Saskatoon serviceberry
Arctostaphylos uva-ursi	Bearberry
Berberis repens	Low oregongrape
Ceanothus sanguineus	Redstem ceanothus
Cornus stolonifera	Red-osier dogwood
Corylus cornuta	
Crataegus columbiana	Columbia hawthorn
Crataegus douglasii	Black hawthorn
Philadelphus lewisii	Mockorange
Prunus virginiana	Common chokecherry
Rhamnus alnifolia	Alder buckthorn
Rhus radicans	Poison ivy

Table 40.

Shrubs (cont.)	
Rosa acicularis	Prickly rose
Rosa gymnocarpa	Baldhip rose
Rosa woodsii	Woods rose
Salix amygdaloides	Peachleaf willow
Salix exigua	Coyote willow
Spiraea douglasii	Douglas spirea
Symphoricarpos albus	Common snowberry
Trees	
Betula occidentalis	Water birch
Betula papyrifera	Paper birch
Juniperus occidentalis	Western juniper
Pinus ponderosa	Ponderosa pine
Populus tremuloides	Quaking aspen
Populus trichocarpa	Black cottonwood

The variation in vegetative composition, even within the same general habitat type, is evident for all habitat types. A species list is presented for the transects and habitat types sampled within each segment. The more communities and, up to a point, the more transects sampled, the longer would be the species list.

Wildlife

Big game

The big game animals in our study area are mule deer, white-tailed deer, elk, and pronghorn, in order of abundance. Elk (150) and pronghorn (8) were on West Bar (right bank near RM 440).

One white-tailed deer has been reported from the Hanford Reservation, but the main white-tailed populations occur along F.D.R. Lake northward. White-tailed deer also occur along Rufus Woods Lake. Mule deer occur all through the study region, though north of the Spokane River they comprised only 25 percent of all deer seen.

We conducted the aerial census on big game winter range along the upper Columbia river on 20 and 21 February 1975 (Table 41), using a Cessna 182 airplane with a pilot and two observers. We counted 352 white-tailed deer, 327 mule deer, 150 elk, and 8 pronghorns. We observed all white-tailed deer along Lake Franklin D. Roosevelt (all but 15 north of the Spokane River), and all elk and pronghorns on West Bar (on right bank in vicinity of RM 440). We counted 52 mule deer along the Hanford stretch. Earlier in the month Battelle counted 100 mule deer within 100 yards of the river (Table 42). The difference probably is influenced by better visibility of deer during the Battelle count, because the ground was covered with snow at that time. The entire deer population on the Hanford Reservation is estimated at 125 deer (pers. Comm.. Biologist John Hedlund, Battelle Pacific Northwest Laboratories). This suggests virtually all deer on this area winter along the Columbia River, thus further suggesting the possible importance of the shoreline riparian growth as winter forage for the deer on the Hanford Reservation.

We saw no deer along Priest Rapids, Rock Island, Rocky Reach and Wells pools, and ground evidence of their occurrence only along Rocky Reach. U.S. Fish and Wildlife Service Biologist Ron Starkey counted 294 deer within 500 feet of the shoreline at Rufus Woods pool, during a flight conducted 14 February 1975. We counted only 25 deer on 20 February (Table 41) while covering the same area. Our observation efficiency from the air is probably something less than 50%, at least in the forested country from Grand Coulee Dam to the British Columbia border. Therefore, the deer population using the shoreline during winter would be substantially denser than we observed.

Ground observation in winter of big game or its sign was made on or near all transects. Except perhaps for the Rock Island segment, much

Table 41. Aerial big game and coyote census along the upper Columbia River during 20-21 February 1975.

	Hanford	Priest Rapids	Wanapum	Rock Island	Rocky Reach	Wells	Chief Joseph	South FDR	North FDR	Total
Elk										
Right bank	0	0	150	0	0	0	0	0	0	150
Mule deer										
Right bank	48	0	9	0	0	0	10	164	0	231
Left bank	0	0	0	0	0	0	14	68	8	90
Island	4	0	1	0	0	0	1	0	0	6
Total	52[a]	0	10	0	0	0	25[b]	232	8	327
White-tailed deer										
Right bank	0	0	0	0	0	0	0	0	203	203
Left bank	0	0	0	0	0	0	0	15	134	149
Total	0	0	0	0	0	0	0	15	337	352
Antelope										
Right bank	0	0	8	0	0	0	0	0	0	8
Coyote										
Right bank	0	0	0	0	0	0	0	0	6	6
Left bank	0	0	0	0	0	0	1	0	3	4
Total	0	0	0	0	0	0	1	0	9	10

[a]During a flight conducted by Battelle Pacific Northwest Laboratories on 7 February 1975, 100 mule deer were counted within 300 feet of the shoreline (see Table 41).

[b]During a flight conducted by the U.S. Fish and Wildlife Service on 14 February 1975, 114 and 180 mule deer were seen within 500 feet of the shoreline on the right and left banks, respectively.

Table 42. Aerial census of mule deer within 100 yards of shoreline of Hanford segment of Columbia River, conducted by Biologist John Hedlund of Battelle Pacific Northwest Laboratories, 7 February 1975, with snow on the ground.

Location	Deer seen
D area	28
White Cliffs area	25
100 F	19
Scattered elsewhere	28
	100[a]

[a]Within this same area, 105 deer were counted from the road by technicians of Battelle Pacific Northwest Laboratories on 15 January 1975.

of which borders the urban areas of Rock Island, east Wenatchee, and Wenatchee, and its associated industries and orchard farming, most of the shoreline of the upper Columbia is used extensively by deer during winter. Unlike the wintering elk on West Bar, specific concentrations of wintering deer are few. The deer using the shoreline of Rocky Reach pool during winter, for example, tend to be generally distributed along both banks. Some small concentrations do occur on the right bank where the canyons tend to funnel the deer to the shoreline. Many deer using this area in winter are victims of mortality from automobiles, since the roads run parallel to the reservoir (Pers. comm. Roger McKeel, Washington Dept. of Game). About 75% of the deer north of the Spokane River are white-tailed deer. Below that mostly mule deer occur, except along Rufus Woods Lake white-tailed deer occur often. One female white-tailed deer has been recorded on Lake Island in the Hanford segment of the river (O'Farrel and Hedlund 1972). Hedlund et al. (1973) reported a marked preference by female mule deer to fawn on the islands in the Hanford segment of the river. In the 5 years from 1969 through 1973, 230 fawns were tagged, mostly on the Hanford islands. "The data for the past five years... demonstrates a preference for the islands in the Columbia River or for the riparian vegetation near the shoreline" (Hedlund et al. 1973:157).

The seasonal frequency of occurrence listed in Table 44 often involves observation of pellet groups not necessarily evacuated during the season when they were observed. The total values of Table 45 are more realistic. Deer occurred on 58% of the riparian shrub transects, 71% of the riparian tree transects, 92% of the conifer transects, and 74% of the shrub steppe transects. Other habitats have too few transects for comparison.

Despite the many deer wintering along the shorelines of the North FDR and British Columbia transects, we observed few deer carcasses. In April 1975 we aged one dead deer on Transect 59 at 10+ years. The greaseless marrow indicated it had died of starvation perhaps as a result of its old age. We aged two dead deer on Transect 61 at 1.5 and 8.5 years. During this time we observed numerous deer in groups of 5 to 30 grazing in open areas about 0.5 to 1.0 km back from the shoreline, and most appeared in poor condition. The deer (mostly white-tails) have browsed the snowbush heavily, removing all evergreen leaves on many of the plants. Many pellet groups tended to be distributed around clumps of snowbush.

Sampling intensity for pellet groups was low. Pellet groups were present if not abundant on many transects, yet not encountered during sampling (Table 46). Part of the reason may be that deer, human, and other conspicuous trails were avoided to assist sampling of vegetation. Pellet group counts proceeded in conjunction with vegetation measurements. Thus, sampling was biased against pellet groups deposited on deer trails. The sampling indicated the number

Table 43. Occurrence of mammals by segment along the upper Columbia River during winter 1975.

	Occurrence								
	Hanford	Priest Rapids	Wanapum	Rock Island	Rocky Reach	Wells	Chief Joseph	South FDR	North FDR
Elk	-	-	X	-	-	-	-	-	-
Mule deer	X	-	X	-	X	-	X	X	X
White-tailed deer	-	-	-	-	-	-	-	-	X
Coyote	X	X	X	-	X	X	X	X	X
Canid	-	-	-	X	X	X	-	X	X
Raccoon	X	-	-	-	-	-	X	-	-
Badger	-	X	-	-	-	-	-	-	-
River otter	-	-	-	-	-	X	X	-	X
Mink	-	-	-	X	-	-	-	-	-
Skunk	-	-	-	-	X	X	-	-	-
Mountain cottontail	X	X	-	X	X	X	X	X	X
Black-tailed jack rabbit	-	X	X	-	-	-	-	-	-
Lagomorph	-	-	-	-	-	-	-	-	X
Beaver	X	-	-	-	-	-	-	-	X
Porcupine	X	-	-	-	-	-	-	-	X
Red squirrel	-	-	-	-	-	-	-	-	X
Bushy-tailed woodrat	-	X	-	-	-	-	-	-	-

Table 44. Percent frequency of occurrence (occupied transects/total transects) of game mammals by habitat along the upper Columbia River during spring (April-June), summer (July-September, fall (October-December), and winter (January-March). (Number of transects are in parentheses.)

Species	Spring	Summer	Fall	Winter
Willow (10)[a]				
Elk	0	0	0	10
Deer	33	0	0	60
Coyote	0	0	0	40
Skunk	0	0	0	10
Mink	17	10	0	0
Mountain cottontail	0	0	0	20
Black-tailed jack rabbit	0	0	0	10
Rose & dogwood (2)				
Raccoon	0	0	50	0
Skunk	0	0	50	0
Mink	0	0	50	0
Mountain cottontail	50	50	0	50
Lagomorph	50	0	0	0
Total Riparian shrub (12)[a]				
Elk	0	0	0	8
Deer	25	0	0	50
Coyote	0	0	0	33
Raccoon	0	0	8	0
Skunk	0	0	8	0
Mink	13	8	8	0
Mountain cottontail	13	8	0	25
Black-tailed jack rabbit	0	0	0	8
Lagomorph	13	0	0	0
Cottonwood (5)[b]				
Elk	0	0	0	0
Deer	40	40	0	0
Black bear	0	40	0	0
Coyote	0	20	0	0
Raccoon	0	20	0	0
Beaver	20	0	0	25
Striped skunk	0	20	0	0
Mink	0	40	0	0
Mountain cottontail	0	20	20	50
Lagomorph	0	0	0	25
Porcupine	20	20	0	0
Red squirrel	20	20	0	0

Table 44. Cont.

Species	Spring	Summer	Fall	Winter
Birch (2)[b]				
Deer	0	50	0	0
Raccoon	0	50	0	0
Mink	0	50	0	0
Lagomorph	0	0	0	100
Red squirrel	0	100	0	0
Total riparian tree (7)[b]				
Elk	0	0	0	0
Deer	28	42	0	0
Black bear	0	28	0	0
Coyote	0	14	0	0
Raccoon	0	28	0	0
Beaver	14	0	0	20
Striped skunk	0	14	0	0
Mink	0	42	0	0
Mountain cottontail	0	44	14	40
Lagomorph	0	0	0	40
Porcupine	14	14	0	0
Red squirrel	14	42	0	0
Equisetum (1)				
Deer	0	0	0	100
Coyote	0	100	0	0
Northern pocket gopher	0	0	0	100
Grassland (2)[c]				
Deer	50	50	0	50
Coyote	0	100	0	50
Badger	0	0	0	50
Mink	0	50	0	0
Porcupine	0	50	0	0
Northern pocket gopher	0	0	0	50
Total grassland & equisetum (3)[c]				
Deer	0	33	0	67
Coyote	0	100	0	33
Badger	0	0	0	33
Mink	0	33	0	0
Porcupine	0	33	0	0
Northern pocket gopher	0	0	0	67
Cobble (3)				
Deer	67	67	0	100
Coyote	0	33	0	33
Raccoon	0	33	0	0
Porcupine	0	33	0	0
Northern pocket gopher	0	0	33	33

Table 44. Cont.

Species	Spring	Summer	Fall	Winter
Shoreline gravel (1)				
Mink	100	0	0	0
Total cobble & gravel (4)				
Deer	50	50	0	75
Coyote	0	25	0	25
Raccoon	0	25	0	0
Mink	25	0	0	0
Porcupine	0	25	0	0
Northern pocket gopher	0	0	0	50
Ponderosa pine with shrub steppe (5)[d]				
Deer	20	20	20	50
Black bear	20	0	0	0
Coyote	0	20	20	50
Mountain cottontail	0	0	0	25
Porcupine	20	0	20	0
Red squirrel	40	0	20	0
Chipmunk	40	0	0	0
Ponderosa pine with broadleaf shrub (4)[d]				
Deer	50	50	50	33
Coyote	25	75	25	100
Raccoon	50	50	0	0
Weasel	0	0	25	0
River otter	0	0	0	33
Porcupine	0	0	0	33
Red squirrel	25	50	0	33
Northern pocket gopher	25	0	0	0
Chipmunk	50	75	25	0
Ponderosa pine with no shrubs (2)[d]				
Deer	50	0	0	100
Black bear	100	0	0	0
Coyote	50	50	50	100
Raccoon	50	50	50	0
Mink	0	50	0	0
Mountain cottontail	0	50	0	0
Red squirrel	0	50	50	100
Chipmunk	50	50	0	0

Table 44. Cont.

Species	Spring	Summer	Fall	Winter
Juniper (1)				
Deer	100	0	0	0
Coyote	0	100	0	0
Raccoon	0	100	0	0
Lagomorph	0	0	0	100
Total conifer (12)[d]				
Deer	42	25	25	50
Black bear	25	0	0	0
Coyote	17	50	17	75
Raccoon	17	33	0	0
River otter	0	0	0	13
Mink	0	8	0	0
Weasel	0	0	8	0
Mountain cottontail	0	8	0	13
Lagomorph	0	0	0	13
Porcupine	8	0	8	13
Red squirrel	25	25	17	25
Northern pocket gopher	8	0	0	0
Chipmunk	42	0	0	0
Sagebrush (9)[e]				
Elk	13	0	11	13
Deer	50	22	11	38
Coyote	13	22	11	38
Canid	0	0	0	13
Raccoon	0	11	0	13
Beaver	13	0	0	13
Badger	0	11	0	25
River otter	0	11	0	38
Skunk	0	0	22	0
Mink	0	0	0	13
Mountain cottontail	38	11	11	38
Black-tailed jack rabbit	13	11	0	13
Lagomorph	25	0	0	0
Yellow-bellied marmot	13	0	0	0
Porcupine	13	0	0	0
Northern pocket gopher	0	0	0	25
Chipmunk	13	0	0	0
Rabbitbrush (4)[e]				
Coyote	25	25	0	0
Raccoon	0	0	25	0
Badger	25	0	0	50
Mink	25	0	0	0
Mountain cottontail	0	0	0	50
Porcupine	0	25	25	0
Northern pocket gopher	50	0	25	0

Table 44. Cont.

Species	Spring	Summer	Fall	Winter
Bitterbrush and other desert shrubs (6)				
Elk	0	0	0	17
Deer	33	17	0	83
Coyote	17	50	33	50
Raccoon	17	33	0	0
Beaver	17	0	0	0
Badger	17	0	0	17
Mink	0	17	0	0
Mountain cottontail	17	0	0	0
Black-tailed jack rabbit	33	0	0	50
Lagomorph	17	0	0	0
Porcupine	0	17	0	0
Gopher	17	0	0	0
Chipmunk	17	0	0	0
Total shrub steppe (19)[e]				
Elk	11	0	0	13
Deer	33	16	5	50
Coyote	17	32	16	38
Canid	0	0	0	6
Raccoon	6	16	5	6
Beaver	11	0	0	6
Badger	11	5	0	25
River otter	0	5	0	19
Skunk	0	0	11	0
Mink	6	5	0	6
Mountain cottontail	22	5	5	25
Black-tailed jack rabbit	17	5	0	25
Lagomorph	17	0	0	0
Yellow-bellied marmot	6	0	0	0
Porcupine	6	11	5	0
Northern pocket gopher	17	0	5	19
Chipmunk	11	0	0	0
Sand dune (2)				
Elk	0	0	0	50
Deer	0	50	0	50
Coyote	0	0	100	100
Mountain cottontail	0	0	0	50
Black-tailed jack rabbit	50	0	50	50
Lagomorph	50	0	0	0
Porcupine	0	50	0	0

[a]Four transects were not sampled in spring.

[b]One cottonwood and one birch transect was not sampled in winter.

[c]One grassland transect was not sampled in spring.

[d]Two ponderosa pine-shrub steppe transects, one ponderosa pine-broadleaf shrub transect, and one ponderosa pine-no shrub transect were not sampled in winter.

[e]One sagebrush transect was not sampled in spring or winter, and two rabbitbrush transects were not sampled in winter.

Table 45. Frequency of occurrence (occupied transects/total transects) of game mammals found in the general habitat types sampled along the upper Columbia River 1974-75. (Number of transects are in parentheses.)

	Riparian shrub (12)	Riparian tree (7)	Equisetum (1)	Grassland (2)	Cobble & gravel (4)	Conifer (12)	Shrub steppe (19)	Sand dune (2)	Supplemental[a]
Elk	8	0	0	0	0	0	11	50	X
Deer (unidentified)[b]	58	71	100	100	75	92	74	100	X
Mule deer	0	0	0	0	0	0	0	0	X
White-tailed deer	0	0	0	0	0	0	0	0	X
Pronghorn antelope	0	0	0	0	0	0	0	0	X
Black bear	0	28	0	0	0	25	0	0	X
Lynx	0	0	0	0	0	0	0	0	X
Bobcat	0	0	0	0	0	0	0	0	X
Coyote	33	14	100	0	25	83	58	100	X
Canid (unidentified)	0	0	0	0	0	0	5	0	X
Raccoon	8	28	0	0	25	42	26	0	X
Beaver	0	14	0	0	0	0	16	0	X
Badger	0	0	0	50	0	0	32	0	X
River otter	0	0	0	0	0	8	16	0	X
Striped skunk	0	14	0	0	0	0	0	0	X
Skunk (unidentified)	8	0	0	0	0	0	11	0	X
Mink	25	42	0	50	25	8	16	0	X
Long-tailed weasel	0	0	0	0	0	0	0	0	X
Weasel (unidentified)	0	0	0	0	0	8	0	0	X
Muskrat	0	0	0	0	0	0	0	0	X
Mountain cottontail	25	28	0	0	0	17	37	0	X
Black-tailed jack rabbit	8	0	0	0	0	0	26	50	X
Lagomorph (identified)	8	28	0	0	0	8	21	50	X

[a]Occurrence is indicated by "X."

[b]Mostly mule deer below the Spokane River; mostly white-tailed deer above the Spokane River. Most observations were of pellets and tracks.

Table 46. Deer pellet group density by habitat along the upper Columbia River, April 1975.

Transect	No. pellet groups counted[a]	No. pellet groups/ha	
Willow			
11	X	54	
12	X	54	
21	X[b]	54	
35	X	54	
36	X	54	
38	0	0	
69	0	0	
70	X	54	
71	X	54	
72	X	54	
Mean	0.40	44	Transects occupied = 80%
Rose & Dogwood			
24	0	0	
29	X	54	
Mean	0.50	27	Transects occupied = 50%
Grand mean	0.38	42	Transects occupied = 75%
Cottonwood			
25	0	0	
27	X	54	
63	8	875	
64	0	0	
65	X	54	
Mean	1.80	198	Transects occupied = 60%
Birch			
60	X	54	
66	X	54	
Mean	0.50	54	Transects occupied = 100%
Grand mean	1.43	156	Transects occupied = 71%
Equisetum			
6	X	54	Transects occupied = 100%

Table 46. Cont.

Transect	No. pellet groups counted[a]	No. pellet groups/ha	
Grassland			
8	X	54	
68	X	54	
Grand mean	0.50	54	Transects occupied = 100%
Cobble			
2	X	54	
9	X	54	
33	X	54	
Mean	0.50	54	Transects occupied = 100%
Shoreline gravel			
40	X	54	Transects occupied = 100%
Grand mean	0.50	54	Transects occupied = 100%
Ponderosa pine & desert shrub			
44	X	54	
50	1	109	
54	X	54	
56	1	109	
Mean	0.75	82	Transects occupied = 100%
Ponderosa pine & broadleaf shrub			
47	X	54	
51	2	217	
57	X	54	
67	3	329	
Mean	1.50	163	Transects occupied = 100%

Table 46. Cont.

Transect	No. pellet groups counted[a]	No. pellet groups/ha	
Ponderosa pine & ground plants			
58	0	0	
59	5	546	
61	2	217	
Mean	2.33	255	Transects occupied = 67%
Juniper			
62	X	54	Transects occupied = 100%
Grand mean	1.38	151	Transects occupied = 92%
Sagebrush			
1	X	54	
18	0	0	
20	X[b]	54	
26	X	54	
28	3	329	
41	X	54	
43	X	54	
46	1	109	
Mean	0.81	89	Transects occupied = 88%
Bitterbrush			
19	X[b]	54	
32	X	54	
45	4	435	
Mean	1.67	183	Transects occupied = 100%
Rabbitbrush			
4	X	54	
7	X	54	
49	0	0	
53	X	54	
55	X	54	
Mean	0.40	44	Transects occupied = 80%

Table 46. Cont.

Transect	No. pellet groups counted[a]	No. pellet groups/ha	
Other desert shrub			
13	X	54	
31	X	54	
37	X	54	
Mean	0.54	54	Transects occupied = 100%
Grand mean	0.79	86	Transects occupied = 89%
Sand dune			
3	X	54	
19	X[a]	54	
Grand mean	0.50	54	Transects occupied = 100%

[a]Where no pellet groups were sampled but were observed to be present on the transect, presence (X) was indicated, and arbitrarily assigned a value of 0.5 pellet groups sampled, or 54 pellet groups/hectare.

[b]Both elk and deer were present on these transects.

of pellet groups per ha was 42 for riparian shrub, 156 for riparian tree, 151 for conifer, and 86 for shrub steppe. The transects on which pellet groups were encountered amounted to 75% for riparian shrub, 71% for riparian tree, 92% for conifer, and 89% for shrub steppe.

The deer in the Hanford segment tend to use the shoreline, and particularly the riparian habitat, year round, probably because water is not generally available elsewhere on the reservation. This probably is a limiting influence on the population, and tagged deer have been shot "...as far as 20 miles from their original fawning grounds" (Hedlund et al. 1973:157). The total of 125 deer for the entire Hanford Reservation, estimated by Battelle Pacific Northwest Laboratories, produced at least 48 fawns tagged in 1973. By comparison, the density of deer using the shoreline along the northern segments, based on pellet group counts, seems higher (Table 47).

Actual deer numbers are impossible to determine in a survey such as this, since not all the winter range lies along the shore. Two sorts of indices of population size have nevertheless been obtained: aerial counts and pellet-group transects. In each case, of course, the count is affected by the variables of relative visibility and of relative degree of seasonal concentration. Still, such indices obtained under similar conditions yield roughly comparable results.

One aerial census taken February 20 and 21, 1975 over the whole area gave total counts of: 8 pronghorn; 150 elk; 327 mule deer; and 352 white-tailed deer. White-tailed deer are found in the north, where denser cover impedes visibility, but also where there is more snow to concentrate the deer.

Along the Hanford stretch, where 100-125 deer were wintering, 52 were counted on this flight. Along Rocky Reach 25 deer were counted on the flight, but on a flight made 10 days earlier USFWS biologist Ron Starkey counted 294.

In recording pellet groups, there were two levels of observation. When a transect was run the presence or absence of pellets was recorded. This was the only record when pellet density was low. When pellet density was higher, an attempt was made to determine the number of groups present per hectare. The two sorts of record were made comparable by assuming that the presence of pellets constituted a pellet-group density of 54/ha. If we divide this by 13 we get about 4 deer/days per ha. Using this crude yardstick we get the following estimates for deer use from our transects: Hanford - 4 deer days/ha; Priest Rapids - 4; Wanapum - 3; Rock Island - 2; Rocky Reach - 6; Wells - 3; Rufus Woods - 10; South FDR - 7; North FDR - 11; Northern Free-flowing - 17.

Table 47. Deer pellet group density by segment of the upper Columbia River, April 1975.

Transect	No. pellet groups counted[a]	No. pellet groups/ha
Hanford		
1	X	54
2	X	54
3	X	54
4	X	54
6	X	54
7	X	54
8	X	54
9	X	54
71	X	54
72	X	54
Mean	0.5	54
Priest Rapids		
11	X	54
12	X	54
13	X	54
Mean	0.5	54
Wanapum		
18	0	0
19	X[b]	54
20	X[b]	54
21	X[b]	54
Mean	0.38	40
Rock Island		
24	0	0
25	0	0
26	X	54
27	X	54
Mean	0.25	27

Table 47. Cont.

Transect	No. pellet groups counted[a]	No. pellet groups/ha
Rocky Reach		
28	3	329
29	X	54
31	X	54
32	X	54
33	X	54
69	0	0
70	X	54
Mean	0.79	86
Wells		
35	X	54
36	X	54
37	X	54
38	0	54
40	X	54
Mean	0.40	44
Rufus Woods		
41	X	54
43	X	54
44	X	54
45	4	435
46	1	109
47	X	54
Mean	1.17	128
South FDR		
49	0	0
50	1	109
51	2	217
53	X	54
54	X	54
55	X	54
Mean	0.75	82

Table 47. Cont.

Transect	No. pellet groups counted[a]	No. pellet groups/ha
North FDR		
56	1	109
57	X	54
58	0	0
59	5	546
60	X	54
61	2	217
68	X	54
Mean	1.36	148
B.C.		
62	X	54
63	8	875
64	0	0
65	X	54
66	X	54
67	3	329
Mean	2.08	227

[a]Where no pellet groups were sampled but were observed to be present on the transect, presence (X) was indicated, and arbitrarily assigned a value of 0.5 pellet groups sampled, or 22 pellet groups/hectare.

[b]Both elk and deer present.

We were also interested in obtaining information on winter diets, so we made representative pellet collections in mid-spring from Wanapum (both mule deer and elk), Rocky Reach (mule deer), Rufus Woods (mule deer), South FDR (Sherman Creek - white-tailed deer), Northern Free-flowing Segment collections at transects 62 and 63- probably white-tailed deer.

West Bar, of the Wanapum pool, is shrub steppe with much sagebrush and bitterbrush. The main elk winter and early spring foods, in order of abundance, were: Bitterbrush (22%), Needlegrass (18%), Balsamroot (13%), Wheatgrass (9%), Willow (8%), Cheatgrass (7%), Serviceberry (6%), Buckwheat (3%), Winterfat (2%), Lupine (2%), and Fescue (2%).

The main mule deer late winter/early spring foods on this same range were: Bitterbrush (64%), Buckwheat (18%), Balsamroot (4%), Lupine (3%), Sage (3%), Willow (2%), and Serviceberry (2%). It is apparent that certain plants are taken in quantity by both mule deer and elk on this same range: Bitterbrush, Buckwheat, Balsamroot, Willow, Lupine, and Serviceberry. These constitute virtually the whole diet of the deer, but only half the diet of the elk. Thus there appears to be a potential for competitive pressure by the elk on the mule deer. It would of course be necessary to get an estimate of the relative availability of these various forage plants on West Bar, and also of late summer livestock diets there, to determine whether there was a managerial problem.

We can derive a rough index of preference by comparing the percentage of a plant species in the winter diet with the frequency of that plant in our shrub-steppe transects. For example, bitterbrush made up 22 percent of the elk diet, and occurred with a frequency of 31 on the shrub-steppe transects (Table 24). Dividing 22 by 31 gives us a "preference index" of 0.7. In contrast, balsamroot made up 13 percent of the diet and had a frequency of 10, for a "preference index" of 1.3. From this one could conclude that balsamroot is prefered to bitterbrush by these elk in winter.

Some species occur at such low density that they do not show up as having any measureable frequency in Table 24, and yet they form an appreciable part of the winter diet. If we assign an arbitrary frequency of 1 to them, we can derive their preference ratings.

Ideally, the quantitative data on food habits should be combined with quantitative data on available winter forage for the derivation of an accurate "preference rating." Here we take plant frequency as a measure of availability, but a better measure would be expressed as a weight or volume per unit area. This intensity of measurement was not possible in our study, but we mention it here as a possibility for future work on food habits.

Table 48 . Elk and mule deer winter diets and preference ratings: West Bar - Wanapum Pool.

Species	% Elk Winter Diet	% Mule Deer Winter Diet	"Elk Preference"	"Deer Preference"
Grasses				
Needlegrass	18	0	1.3	0
Wheatgrass	9	0	0.2	0
Cheatgrass	7	0	0.1	0
Fescue	2	0	0.1	0
Forbs				
Balsamroot	13	4	1.3	0.4
Lupine	2	3	2.0	3.0
Buckwheat	3	18	3.0	18.0
Shrubs				
Bitterbrush	22	64	0.7	2.0
Serviceberry	6	2	6.0	2.0
Winterfat	2	0	2.0	0
Sage	0	3	0	0.1
Rabbitbrush	0	0	0	0

Grasses are obviously of greater value to elk than to deer; among the grasses Needlegrass (2 species) is obviously sought by the elk. It would be important to know whether there is a difference between the two species in elk preference. Of the forbs, buckwheat is selected by both deer and elk, but it is apparently much more important to deer. Of the shrubs, bitterbrush is important to both deer and elk, but is more intensively used by deer.

Sage and rabbitbrush, though abundant, are not important winter food items for either elk or deer on West Bar.

Mule deer winter pellets from Rocky Reach and Rufus Woods shrub-steppe were also analyzed. They show diets similar to that of the mule deer on West Bar, with bitterbrush a mainstay, buckwheat and balsamroot important, and serviceberry and lupine taken in small amounts, presumably because these species are not abundant and productive in the shrub-steppe community.

We also collected deer winter pellets from several more northern locations, with the following results (Table 47).

Table 49. Percent relative density (percent dry weight) of discerned plant fragments from mule deer, white-tailed deer, and elk feces collected from winter ranges along the upper Columbia River, 23-26 June 1975.

Species	West Bar[ae]	West Bar[be]	Swakane Canyon[bf]	Rufus Woods Lake[c]	Transect 56[d]	Transect 59[d]	Sherman Creek burn[dg]	Transect 62[d]	Transect 63[d]
Grasses									
Agropyron spp. (Wheatgrass)	9.27	-	-	-	-	-	-	-	-
Bromus tectorum (Cheatgrass brome)	6.65	<1	<1	-	-	-	<1	-	-
Festuca spp. (Fescue)	1.74	-	-	-	-	-	1.37	<1	-
Oryzopsis spp. (Ricegrass)	1.15	<1	-	-	-	-	-	-	-
Stipa spp. (Needlegrass)	17.96	<1	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	<1	-	<1
Forbs									
Achillea spp. (Yarrow)	<1	<1	-	-	-	-	-	-	-
Balsamorhiza spp. (Balsamroot)	12.73	3.91	13.35	5.33	-	<1	1.73	-	-
Equisetum spp. (Horsetail)	1.15	-	-	-	<1	<1	51.13	2.48	2.61
Erigeron spp. (Fleabane, daisy)	-	-	<1	-	-	-	-	-	-
Erigonum spp. (Buckwheat)	2.93	17.68	28.17	6.98	-	-	-	-	-
Lomatium spp. (Biscuitroot, Lomatium)	1.15	-	<1	-	-	-	-	-	-
Lupinus spp. (Lupine)	1.74	2.81	1.21	3.53	<1	5.64	7.96	-	-
Unknown moss	<1	-	-	-	-	-	-	-	-
Unknown	2.93	-	-	2.11	-	-	-	1.48	<1
Shrubs									
Amelanchier alnifolia (Saskatoon serviceberry)	6.01	2.38	-	5.03	41.99	3.50	2.45	28.06	16.02
Artemisia spp. (Sagebrush)	1.15	3.35	4.51	<1	-	-	-	-	-
Berberis repens (Low oregongrape)	-	-	-	2.11	5.86	13.69	3.93	17.96	59.51
Ceanothus velutinus (Snowbrush)	-	-	-	-	-	69.40	19.58	-	-
Chrysothamnus spp. (Rabbitbrush)	-	1.49	1.21	-	-	-	-	-	-
Crataegus spp. (Hawthorn)	-	-	-	-	-	-	-	-	5.10
Eurotia lanata (Winterfat)	2.32	-	-	-	-	-	-	-	-
Philadelphus spp. (Mockorange, syringa)	-	-	-	-	1.86	-	-	-	-
Prunus spp. (Cherry, chokecherry, plum)	-	-	-	-	3.32	-	-	<1	<1
Purshia tridentata (Antelope bitterbrush)	22.01	64.05	43.97	71.28	27.39	-	-	-	-
Rosa spp. (Rose)	-	-	2.49	-	<1	-	1.73	-	<1
Salix spp. (Willow)	7.95	2.38	4.17	-	-	-	-	-	-
Unknown	-	<1	-	1.30	2.84	<1	-	<1	-

Table 49. Cont.

Species	West Bar[ae]	West Bar[be]	Swakane Canyon[bf]	Rufus Woods Lake[c]	Transect 56[d]	Transect 59[d]	Sherman Creek burn[dg]	Transect 62[d]	Transect 63[d]
Trees									
Juniperus occidentalis (Western juniper)	-	-	-	1.03	-	-	-	22.36	1.61
Pinus ponderosa (Ponderosa pine)	-	-	-	-	14.42	5.36	8.39	5.10	2.62
Populus spp. (Cottonwood, poplar, aspen)	-	-	-	-	-	-	-	20.11	10.30
Pyrus malus (Apple)	-	-	-	-	-	<1	1.03	-	-
Tsuga spp. (Hemlock)	-	-	-	<1	-	-	-	-	-

[a]Elk

[b]Mule deer

[c]Mostly mule deer, but some white-tailed deer; pellets collected from November and December 1974, January and February 1975.

[d]Mostly white-tailed deer, but some mule deer.

[e]Pellets collected near Transects 20 and 21.

[f]Pellets collected along shoreline at mouth of Swakane Canyon near Rocky Reach Dam.

[g]Pellets collected from a burned area on the Washington Game Department's Sherman Creek Wildlife Recreation Area near the U.S. National Park Serivce's Hague Campground, but about 1000 meters from the shoreline.

On North FDR, at Transect 56, probable white-tail pellets showed: Serviceberry (42%), Bitterbrush (27%), Ponderosa pine (14%), Oregon-grape (6%), Cherry (3%) and Mockorange (2%).

Also on North FDR, at Transect 59, deer pellets showed: Snow-brush (*Ceanothus velutinus*) (70%), Oregongrape (14%), Lupine (6%), Ponderosa pine (5%), and Serviceberry (4%).

At Sherman Creek, an important white-tail wintering area, pellets showed: Horsetail (51%), Snowbrush (20%), Lupine (8%), Ponderosa pine (8%), Oregongrape (4%), and Serviceberry (2%).

At Transect 62, on the Northern Free-flowing Segment, a Juniper transect, deer pellets showed: Serviceberry (28%), Juniper (22%), Ponderosa pine (20%), Oregongrape (18%), and Equisetum (2%).

At Transect 63, a cottonwood transect, deer pellets showed Oregongrape (60%), Serviceberry (16%), Cottonwood (10%), Hawthorn (5%), Ponderosa pine (3%) and Equisetum (3%).

It is apparent that some riparian plants are taken as food by big game, and would presumably be taken to a greater extent if they were more available. These are willow (species), Horsetail, cottonwood, and perhaps cherry. The very large intake of Horsetail by deer on the Sherman Creek winter range is an unexpected finding that deserves further study.

Both the elk and the pronghorns were recorded only on West Bar on the right bank along Wanapum pool. These elk will swim the river here, and are a nuisance to the golf course at Crescent Bar. Some of these elk have remained on the left side of the river. The herd of eight pronghorns observed apparently is the entire herd (Pers. comm., Ellis Bowhay, Washington Department of Game).

Black bears were recorded on 40% (2) of the cottonwood transects (63 and 65) during fall 1974 (Table 44). Numerous clumps of bear scat, consisting solely of chokecherry seeds, were distributed throughout the area adjacent to Transect 65. Bear hunting is popular in this area. On 9 and 10 April 1975 we noted extensive black bear use on three (27%) ponderosa pine transects along North FDR near Kettle Falls and Gifford. Transect 56 had 33 (100%) old logs and stumps torn apart, and 15 pines debarked to some degree. Due to the late spring in 1975, little vegetation was available to the bears as they emerged from dens, and they might have foraged for insect larvae to a greater extent than usual. We observed no such bear use in this area at the same time in 1974 when a warmer spring prevailed.

Although cougars occur in Colville National Forest adjacent to Lake FDR, no evidence was observed of their occurrence along the shoreline. However, they may use the shoreline to some extent during winter to prey on the deer wintering there.

Upland Game

The game mammals, hares and rabbits, found in the study region, included the mountain cottontail, the black-tailed jack rabbit and probably the snowshoe hare. Evidence of the presence of the white-tailed jack rabbit or the pygmy cottontail was not obtained.

We recorded mountain cottontails (*Sylvilagus nuttalli*) along every segment except British Columbia (Table 51). Mountain cottontails occurred on 25% of the riparian shrub, 28% of the riparian tree, 17% of the conifer and 37% of the shrub steppe transects (Table 45). We recorded black-tailed jack rabbits (*Lepus californicus*) only along the Hanford, Priest Rapids, and Wanapum segments. Black-tailed jack rabbits occurred on 8% of the riparian shrub and 26% of the shrub steppe transects. Unidentified lagomorphs occurred on 8% of the riparian shrub 28% of the riparian tree, 8% of the conifer, and 21% of the shrub steppe transects. Some of the unidentified lagomorphs in the North FDR and British Columbia segments probably were snowshoe hares (*L. americanus*). Where cottontails occurred they were abundant. Jack rabbits did not seem especially abundant.

While cottontails and jack rabbits did not use the riparian shrub very heavily, they probably found much more suitable food along the river than was available inland. Riverside populations of cottontails, especially, were high. Whether woody riparian species are more or less valuable than herbaceous riparian species for cottontails is not known, though it could be determined from pellet analysis. At the same time, however, it should be recognized that establishment of woody riparian vegetation has a literally up-grading effect on the shoreline in that it catches floating organic matter, which adds to the fertility of the site. So cottontails would probably be encouraged by an increase in riparian shrub.

Seven species of upland game birds were observed on the upper Columbia River study area. These included; California Quail, Ring-necked Pheasant, Chukar, Ruffed Grouse, Mourning Dove, Turkey and Gray (= Hungarian) Partridge. In addition to these, Sage and Sharp-tailed Grouse occurred near the southern and Blue Grouse and Spruce Grouse near the northern portion of the study area. For the species which occurred along the shore, we have information on distribution by segments and seasonal occurrence (summer, fall, winter):

Table 50. Distribution of upland game birds on the upper Columbia River.

Segment	Quail	Pheasant	Chukar	Gray Partridge	Ruffed Grouse	Dove	Turkey
Hanford	SFW	SFW	F	-	-	SFW	-
Priest Rapids	SFW	SFW	F	-	-	SFW	-
Wanapum	F	-	FW	-	-	SF	-
Rock Island	SF	-	F	-	-	SF	-
Rocky Reach	S	-	F	-	-	SF	-
Wells	-	SFW	FW	-	-	SFW	-
Rufus Woods	-	S	SFW	W	-	SF	-
South FDR	F	F	F	-	F	S	-
North FDR	FW	SF	W	-	FW	SF	SFW

The transect census techniques employed for the land birds were not satisfactory for the upland game birds for a number of reasons involving the nature of the habitats encountered along the river and the habits of the birds themselves. This will be discussed later in the conclusions section.

While good quantitative data on densities of upland game birds by habitat type are lacking, we do have information on their distribution by segments and seasonal occurrence (Table 52). In addition to this, Table 57 shows the frequency of occurrence on transects by habitat type for the three census periods.

Percent frequency of observation by habitat type is presented in Table 53. The total number of observations is increased if those birds seen during the census but not actually within the boundaries of the transect itself are included. This total frequency of observation is included in Table 53.

Table 51. Game mammals observed along the upper Columbia River, 1973-75.[a]

Hanford	
Mule deer	*(Odocoileus hemionus)*
Deer (unidentified)	*(Odocoileus* spp.*)*
Coyote	*(Canis latrans)*
Raccoon	*(Procyon lotor)*
Beaver	*(Castor canadensis)*
Badger	*(Taxidea taxus)*
Mink	*(Mustela vison)*
Mountain cottontail	*(Sylvilagus nuttallii)*
Black-tailed jack rabbit	*(Lepus californicus)*
Lagomorph	(Unidentified)
Yellow-bellied marmot	*(Marmota flaviventris)*
Porcupine	*(Erethizon dorsatum)*
Northern pocket gopher	*(Thomomys talpoides)*
Priest Rapids	
Mule deer	*(Odocoileus hemionus)*
Deer (unidentified)	*(Odocoileus* spp.*)*
Bobcat	*(Lynx rufus)*
Coyote	*(Canis latrans)*
Badger	*(Taxidea taxus)*
Mink	*(Mustela vison)*
Mountain cottontail	*(Sylvilagus nuttallii)*
Black-tailed jack rabbit	*(Lepus californicus)*
Lagomorph	(Unidentified)
Northern pocket gopher	*(Thomomys talpoides)*
Bushy-tailed woodrat	*(Neotoma cinerea)*
Wanapum	
Elk	*(Cervus canadensis)*
Mule deer	*(Odocoileus hemionus)*
Pronghorn antelope	*(Antilocapra americana)*
Coyote	*(Canis latrans)*
Raccoon	*(Procyon lotor)*
Beaver	*(Castor canadensis)*
River otter	*(Lutra canadensis)*
Mountain cottontail	*(Sylvilagus nuttallii)*
Black-tailed jack rabbit	*(Lepus californicus)*
Lagomorph	(Unidentified)

Table 51. Cont.

Rock Island	
Deer	*(Odocoileus* spp.*)*
Coyote	*(Canis latrans)*
Canid	(Unidentified)
Raccoon	*(Procyon lotor)*
Striped skunk	*(Mephitis mephitis)*
Skunk	*(Mephitis* spp.*)*
Mink	*(Mustela vison)*
Muskrat	*(Ondatra zibethicus)*
Mountain cottontail	*(Sylvilagus nuttallii)*
Lagomorph	(Unidentified)
Porcupine	*(Erethizon dorsatum)*
Rocky Reach	
Mule deer	*(Odocoileus hemionus)*
Deer	*(Odocoileus* spp.*)*
Coyote	*(Canis latrans)*
Canid	(Unidentified)
Raccoon	*(Procyon lotor)*
Skunk	*(Mephitis* spp.*)*
Mountain cottontail	*(Sylvilagus nuttallii)*
Lagomorph	(Unidentified)
Yellow-bellied marmot	*(Marmota flaviventris)*
Porcupine	*(Erethizon dorsatum)*
Northern pocket gopher	*(Thomomys talpoides)*
Wells	
Mule deer	*(Odocoileus hemionus)*
Deer	*(Odocoileus* spp.*)*
Coyote	*(Canis latrans)*
Raccoon	*(Procyon lotor)*
Beaver	*(Castor canadensis)*
River otter	*(Lutra canadensis)*
Mink	*(Mustela vison)*
Skunk	*(Mephitis* spp.*)*
Mountain cottontail	*(Sylvilagus nuttallii)*
Rufus Woods Lake	
Mule deer	*(Odocoileus hemionus)*
White-tailed deer	*(Odocoileus virginianus)*
Deer	*(Odocoileus* spp.*)*
Coyote	*(Canis latrans)*
Raccoon	*(Procyon lotor)*
Beaver	*(Castor canadensis)*
Badger	*(Taxidea taxus)*
River otter	*(Lutra canadensis)*
Skunk	*(Mephitis* spp.*)*
Mountain Cottontail	*(Sylvilagus nuttallii)*
Yellow-bellied marmot	*(Marmota flaviventris)*
Northern pocket gopher	*(Thomomys talpoides)*
Chipmunk	(Unidentified)

Table 51. Cont.

South F.D.R.	
Mule deer	*(Odocoileus hemionus)*
Deer	*(Odocoileus* spp.*)*
Coyote	*(Canis latrans)*
Raccoon	*(Procyon lotor)*
Beaver	*(Castor canadensis)*
Badger	*(Taxidea taxus)*
Weasel	*(Mustela* spp.*)*
Mountain cottontail	*(Sylvilagus nuttallii)*
Porcupine	*(Erethizon dorsatum)*
Skunk	*(Mephitis* spp.*)*
Columbian ground squirrel	*(Spermophilus columbianus)*
Northern pocket gopher	*(Thomomys talpoides)*
North F.D.R.	
Mule deer	*(Odocoileus hemionus)*
White-tailed deer	*(Odocoileus virginianus)*
Deer	*(Odocoileus* spp.*)*
Black bear	*(Urus americanus)*
Coyote	*(Canis latrans)*
Raccoon	*(Procyon lotor)*
Beaver	*(Castor canadensis)*
River otter	*(Lutra canadensis)*
Striped skunk	*(Mephitis mephitis)*
Mink	*(Mustela vision)*
Long-tailed weasel	*(Mustela trenata)*
Mountain cottontail	*(Sylvilagus nuttallii)*
Lagomorph	(Unidentified)
Porcupine	*(Erethizon dorsatum)*
Red squirrel	*(Tamiasciurus hudsonicus)*
Northern pocket gopher	*(Thomomys talpoides)*
Chipmunk	(Unidentified)
Yellow-pine chipmunk	*(Eutamias amoenus)*
B.C.	
Mule deer	*(Odocoileus hemionus)*
White-tailed deer	*(Odocoileus virginianus)*
Deer	*(Odocoileus* spp.*)*
Black bear	*(Urus americanus)*
Coyote	*(Canis latrans)*
Raccoon	*(Procyon lotor)*
Beaver	*(Castor canadensis)*
Mink	*(Mustela vison)*
Lagomorph	(Unidentified)
Porcupine	*(Erethizon dorsatum)*
Red squirrel	*(Tamiasciurus hudsonicus)*
Columbian ground squirrel	*(Spermophilus columbianus)*

Table 51. Cont.

B.C. (cont.)	
Northern pocket gopher	*(Thomomys talpoides)*
Chipmunk	(Unidentified)
Yellow-pine chipmunk	*(Eutamias amoenus)*

[a]Scientific nomenclature from: Hall, E. R. and K. R. Kelson. 1959. Mammals of North America, Ronald Press Co. 1083 pp.; and Ingles, L. G. 1947. Mammals of the Pacific States, Stanford Univ. Press, 506 pp.

Table 52. Occurrence of Upland Game Birds by river segment during the summer, fall, and winter census period.

	Hanford	Priest Rapids	Wanapum	Rock Island	Rocky Reach	Wells	Rufus Woods	South FDR	North FDR
Summer									
California quail	X	X		X	X				
Ring-necked pheasant	X	X				X	X		X
Chukar							X		
Turkey									X
Mourning dove	X	X	X	X	X	X	X	X	X
Fall									
California quail	X		X					X	X
Ring-necked pheasant	X	X				X		X	X
Chukar	X	X	X	X	X	X	X	X	
Ruffed grouse								X	X
Mourning dove	X	X	X	X	X	X	X		X
Turkey									X
Winter									
California quail	X	X			X		X		X
Ring-necked pheasant	X	X				X			
Chukar			X	X		X	X		X
Ruffed grouse									X
Mourning dove	X	X				X			
Turkey									X
Gray partridge							X		

Table 53. Frequency of occurrence (number transects occupied/total transects) of upland game birds by habitat type for summer, fall and winter census periods. Numbers in parentheses indicate frequency of observing the species both on the transect and in the adjacent habitats.

	Riparian shrub	Riparian tree	Grassland	Cobble	Conifer	Shrub steppe	Sand dune
Summer							
California quail	1 (2)	2 (2)			1 (2)	1 (5)	
Ring-necked pheasant	1 (2)	2 (2)		0 (1)	1 (3)	3 (7)	0 (1)
Chukar					0 (1)	0 (4)	
Mourning dove	2 (6)	2 (3)		0 (1)	6 (9)	8 (11)	0 (1)
Fall							
California quail		1 (1)			0 (1)		
Ring-necked pheasant	1 (2)				0 (1)	2 (3)	
Chukar						2 (6)	
Ruffed grouse		3 (4)			1 (1)		
Mourning dove		1 (1)	0 (1)	0 (1)	3 (3)	1 (3)	
Winter							
California quail	1 (1)	1 (2)			0 (1)	0 (2)	
Ring-necked pheasant	2(2)					0 (1)	
Chukar	1 (2)			1 (2)	0 (2)	2 (5)	
Gray partridge						1 (1)	
Ruffed grouse					2 (2)	0 (1)	
Mourning dove				0 (1)			

The game birds seem to make considerable use of the small patches of riparian shrub vegetation and the groves of larger trees. These patches were generally too small for the placement of a transect and thus did not get sampled. An example of this situation is on transect 1, which is located on an island in the Hanford area. The transect itself goes through desert shrub while at the southern end there is a low area supporting thick shrubby vegetation. No game birds were ever observed on the transect although each time the transect was visited pheasants were observed within the shrubby habitat. Tracks were seen in the sand on the transect indicating that pheasants do use the habitat on the transect.

A second example is Transect 31 which also goes through desert shrub. This transect is located on a flat bench land of sandy soil at the base of a high steep bank rising up from the river bottom. On either side of the transect there are patches of more dense willow and deciduous shrubs and off the north end of the transect there is a grove of locust trees. Again no game birds were observed on the transect though California Quail and Ring-necked Pheasant were present in the locust grove and Chukars were present on the steep rocky bank.

These two examples serve to illustrate that in many cases the small patches of habitat utilized by the game birds were not covered by the established transects. It also points up the importance of the shrub and tree habitats that exist along the river. Any efforts to enhance and maintain those patches will benefit game bird populations as well as other smaller birds.

The Columbia River shore has a great potential as upland game bird habitat, but this potential is realized only in small part because of the poor development of riparian vegetation. The riparian vegetation provides cover for several purposes. Where dense riparian thickets exist they are used as escape cover by quail and pheasants. Chukar, forced to the river by fall drought are presumably protected by riparian vegetation. Mourning Doves nest extensively in riparian vegetation.

Riparian vegetation appears not to be as essential for Gray Partridge or Ruffed Grouse, although, of course Ruffed Grouse make use of it in the northern stretch.

It would be difficult to overestimate the value of extensive riparian development for grain-feeding game birds, especially quail and pheasant, in the parts of the river bordered by grain fields. Food is generally abundant in these regions most of the year, but shelter from enemies and from inclement weather is not. The flooding when the present dams were filled must have cut carrying capacity sharply; the potential for raising carrying capacity again has not yet been realized.

Some comments can be made about particular species. Wild turkeys were encountered only near Gifford on FDR. Interviews with local people indicate that turkeys occur (during winter and early spring) along the river between Fruitland and Kettle Falls.

Chukars were most commonly encountered on dry steep rocky banks. These birds apparently move away from the river during the early summer and then come back to the river in the fall and winter.

Mourning Doves are quite abundant and widely distributed during the summer. Their numbers decline with the fall migration and by winter only a few widely scattered individuals remain.

Only one flock of Gray Partridges was observed along the river and this was during the winter census. These birds were common along the roads going through the wheatlands on the plateau away from the river during the fall.

Waterfowl

During fall 1974 through early spring 1975 aerial censuses of waterfowl were conducted from which estimates of wintering populations have been made. In addition to these more systematic counts records were kept of the occurrence of ducks and geese by members of the study team as they were working along the river. These observations along with the information from boat transects have been used to compile seasonal species lists for each river segment.

The aerial censuses were conducted during the hours 0930 to 1430 with approximately half the study area being covered the first day and the remainder being covered the second day. Air speed was maintained at 65 to 80 mph depending on flying conditions and the number of birds encountered. The counts were made by two observers looking out either side of the airplane. Records were kept on a portable cassette recorder by one of the two observers. Based on practice exercises using popcorn kernels strewn on a table top, we believe the population estimates to be accurate to about 10 percent, with most of the error attributable to underestimates of large concentrations.

Canada Goose Nesting and Brooding

Goose nesting surveys have been conducted by the Washington Department of Game, Battelle Pacific Northwest Laboratories, and the University of Washington. Reports of these surveys are available for portions of the river for the years 1973, 1974, and 1975. These surveys are summarized in Table 54 and Appendix O. Table 54 presents the totals for each river segment as available. The surveys from Priest Rapids. Wanapum, Rock Island, and Hanford include the locations of nests (Appendix O).

With the exception of Rock Island which was surveyed twice in 1975, goose nesting density and productivity data are based on a single visit to the area. The timing of the surveys was designed to coincide with the peak of nesting activity when most birds had completed their clutch and were incubating.

Geese nest along all the lower segments. The number of nests counted recently has been: 1973- 278; 1974- 343; and 1975- 354. The number per segment is given in Table [54].

From a study of this table, and a knowledge ofthe variations in the intensity of nest-searching in the different years, it seems clear that the increase from year to year is due to increasing search intensity, particularly on the northern segment. This leads one to suspect that more intensive searches on additional segments might reveal additional goose nesting.

Most goose nests are located on islands, and most islands were eliminated when the dams were closed and the pools formed. The free-flowing Hanford segment, with its many islands, supports about one third of the reproducing population. Priest Rapids, also, has more islands than most pools. It seems evident that establishment of additional islands by manipulating gravel, or by erecting artificial islands in deeper water, probably would raise the carrying capacity of our study area for nesting geese.

Nesting success is influenced, in part, by predation and fluctuation in water level. An overall look at the total nests found in the three years of this study (715) when these nests were located during the incubation period about 20 percent were already "unsuccessful," usually destroyed by predation. On the Hanford segment, where nest study was more intensive, this percentage, for the three years of study, was 11, 45, and 25. From these nest tallies it is not possible to determine how many of the nests ultimately hatched successfully.

More intensive studies at Hanford give some values on production. In 1973, 131 nests were studied. Of these 116 or 89 percent hatched successfully, producing an average of five young each. In the subsequent year coyote predation was more of a problem, and only 75 of 137 nests, or 55 percent hatched successfully.

Very little information is available concerning brooding areas used by the geese and no quantitative data on brooding success. Ellis Bowhay (pers. comm.) has located the major brood areas for Priest Rapids and Wanapum. The agricultural fields on the right bank at RM 410 is used as a brood site along Priest Rapids. Areas used on Wanapum are the alfalfa field on the right bank at RM 418 just below

Table 54. Canada Goose nesting records for the upper Columbia River. Results from nest searches during incubation. Unsuccessful nests were those already broken up at time of search.

	Hanford[a]	Priest Rapids[b]	Wanapum[b]	Rock Island[c]	Rocky Reach[c]	Wells[c]	Rufus Woods[d]
1973							
Total Nests	131	79	33	35	-	-	-
Number Unsuccessful	15	-	-	-	-	-	-
Percent Unsuccessful	11	-	-	-	-	-	-
1974							
Total Nests	89	86	30	43	11	36	8
Number Unsuccessful	56	10	3	2	1	-	-
Percent Unsuccessful	63	12	10	5	9	-	-
1975							
Total Nests	62	101	33	36	13	19	44
Number Unsuccessful	42	4	-	9	5	1	-
Percent Unsuccessful	68	4	-	25	38	.05	

[a]Data are from Battelle Pacific Northwest Labs, Richland.

[b]Data are from Ellis Bowhay, Washington Department of Game, Yakima.

[c]Data are from Joe Foster, Washington Department of Game, Wenatchee.

[d]Data are from Albert Erickson, College of Fisheries, University of Washington.

the Vantage Bridge and on the island and right bank across from Crescent Bar at RM 440. No observations of brooding areas on the other pools are available although it is probable that other low agricultural land adjacent to the river is used by geese.

Joe Foster of the Washington Department of Game reports that 10 of the 35 goose nests found along Rock Island Pool in 1975 were on Rock Island just above the dam. He also reports that he has never seen any broods in that area. This raises the question of what happens to any young which hatch on that island, situated just above the dam.

No systematic search for goose nests was made along FDR pool, though three nests were found in the vicinity of Northport. There are a number of islands, mostly between the Spokane River and Northport, which appear to be suitable habitat for nesting, but due to time limitations, they were not searched.

Most of the nests found (68 percent) were located on islands in the two southernmost segments of the study area -- Hanford and Priest Rapids. The relatively greater number of nests here is probably a reflection of the number of suitable islands and the availability of suitable brooding areas adjacent to the river. Starting at Rock Island Dam and going northward, there are very few islands and those that do exist are quite small and rocky as opposed to the low flat open islands further south which seem to be favored by Canada Geese. The islands on Rock Island and Rocky Reach are mostly the result of railroad grade cuts along the now flooded right-of-way. These islands generally have rocky steep banks and have a rather dense shrub cover.

At the same time that the nest counts were made flocks of non-breeding geese were present as well as some paired birds not at nest sites. This suggests that a primary limiting factor may be the availability of nest sites. There is a large reservoir of birds, some of which may be in breeding condition. Elevated nest bowls designed to be mammalian-predator-proof were installed on the Hanford segment in 1973 and had begun to receive use by some geese in 1975. The platforms were used as perches by hawks and owls as indicated by pellets found in the bowls and on the ground. These platforms may be particularly useful where a heavy riparian shrub develops on islands, since geese avoid nesting in dense woody cover.

Flooding does not seem to be a major problem for the nests located under the present regime of river regulation. In 1974, four of 137 nests on Hanford were found to have been flooded. None of the nests on the other pools were flooded. As indicated, the islands used by geese on Hanford and Priest Rapids are low and flat so that increases in water level of 1-2 feet would flood much of the land area of these islands.

The development of intensive agriculture along the river presents some potential threat to goose populations during summer and winter. Geese forage extensively in the alfalfa and grain fields as well as in the orchard grass. Although these fields provide a favored feeding area, the use of pesticides introduces a potential hazard. Several goose carcasses were found along Rocky Reach and Rock Island pools in the spring of 1975. Tissues of these birds were found to have high concentrations of Endrin, suggesting this pesticide was the cause of death. As agricultural use increases, this problem will become greater.

Although there are suitable islands in FDR, there appears to be very little goose nesting activity. The annual spring draw-down may inhibit goose nesting along this pool. With the water level greatly reduced, the potentially suitable island nest sites are made accessible to mammalian predators. In addition, the nest sites are separated from the water by an expanse of barren mudflat.

The Canada Goose is the only waterfowl species which is reported to nest extensively on this study area. Only two Mallard nests were found along the river and these were on Wanapum pool. However, other waterfowl species generally nest in less conspicuous locations and no systematic search was made of areas likely to be suitable for duck nesting.

Wintering Waterfowl Populations

Aerial waterfowl censuses were conducted September 24-25, October 21-22, November 21-22, December 19-20, January 17-18, and February 20-21. Table 55 presents the estimates of the waterfowl populations using the river at these times. The totals for the study area are given in Appendix M. Species lists of waterfowl observed by season on each segment are given in Table 55.

The most abundant game waterfowl along our stretch of the Columbia River in the fall and winter are the Canada Goose and the Mallard. In addition, there are smaller numbers of Pintail, Green-winged Teal, American Wigeon, Redhead, Canvasback, Scaup, Goldeneye, Bufflehead, Gadwall, Shoveler, and probably other species not identified by us.

Except for the diving ducks which feed primarily on fish and aquatic invertebrates in the river, the abundance and distribution of ducks and geese along the upper Columbia River is a function of events and conditions away from the river as much as the condition of the river itself. This is especially true for the geese and Mallards which forage extensively away from the river. Shifts in agricultural practices in the Columbia Basin bring about changes in waterfowl distribution with geese in particular being attraced to wheatfields and alfalfa fields. There appears to have been a shift in the Canada Goose wintering population southward in response to an increase in the wheat production near the Umatilla National Wildlife

Refuge. In addition, the prevailing weather conditions determine the southward movements of ducks and geese in the fall and early winter and the return northward during the spring migration. As the open water of the numerous small ponds in the Columbia Basin and larger lakes, such as Banks Lake, freezes over, many of the ducks and geese using these waters may move onto the river. Likewise in the spring as the waters open up and snowcover on the agricultural fields melts, there is a shift in the reverse direction, away from the river.

While the geese and Mallards may move around in response to conditions away from the river, other species are more dependent on the river itself. Some of the less abundant dabbling ducks, Gadwalls Shovelers, Teal and Pintail, for example, feed less extensively on land and are dependent on the aquatic vegetation and invertebrates in the river. The diving ducks are, of course, also dependent on the condition of the river. The wintering populations of these species will be influenced by changes in the pattern of river regulation as it affects the growth and distribution of aquatic vegetation and invertebrates.

The annual spring draw-down of FDR reservoir can be expected to influence the spring waterfowl migration. Many of the shallow sloughs favored by the ducks are mudflats during the spring. This is made particularly obvious at Kettle Falls where the wide pool present at normal water levels is reduced to a narrow band of water with barren mudflats on either bank. By reducing the growth of aquatic vegetation this draw-down may also affect the number of wintering waterfowl which can be supported.

Table 55 presents the waterfowl totals for each month by river segment, but the river was divided into 5-mile section for the aerial censuses.

Using the observations from the month of December as representative, the distribution of waterfowl within each segment is described in the paragraphs that follow. The total number of individuals and the species composition varied each month but the general pattern of usage remained essentially the same each month.

Of the 17,880 dabbling ducks counted on Hanford, 17,185 (96 percent) were found on the sloughs and shallow water between RM 365 and 370; and 590 (3 percent) were located between RM 350 and 355 -- another area of islands and shallow water. The remaining dabbling ducks

Table 55. Estimates of waterfowl present on or along the upper Columbia River during aerial counts: 25 and 26 Sept; 17 and 18 Oct; 21 and 22 Nov; 19 and 20 Dec 1974: 17 and 18 Jan; and 20 and 21 Feb 1975.

Species	Hanford SEP	OCT	NOV	DEC	JAN	FEB
Loon (sp.)	-	1	-	2	-	-
Grebe (sp.)	-	-	1	2	1	-
Western grebe	-	-	1	8	1	-
Great blue heron	46	58	54	65	38	66
Whistling swan	-	-	8	-	5	-
Canada goose	144	124	863	385	1756	1183
Geese/100 river miles	279	241	1675	748	3410	2300
Mallard	190	6184	15,172	680	17,172	2478
Pintail	-	-	-	-	-	-
Green-winged teal	-	-	-	-	-	-
American wigeon	-	5	7	-	-	-
Redhead	-	-	-	-	-	-
Canvasback	-	-	-	5	15	-
Scaup	-	-	-	3	16	-
Goldeneye	-	-	-	-	-	-
Bufflehead	-	-	8	135	209	23
Merganser	16	6	5	9	2	16
Coot	1	-	-	-	15	-
White pelican	-	-	5	5	-	-
Unidentified ducks	-	118	136	17,200	-	-
Total ducks	206	6313	15,328	18,032	17,414	2517
Ducks/100 river miles	400	12,260	29,764	35,015	34,740	5080

Table 55. Cont.

Species	Priest Rapids SEP	OCT	NOV	DEC	JAN	FEB
Loon (sp.)	-	1	4	2	-	-
Grebe (sp.)	-	-	-	-	-	-
Western grebe	11	-	-	-	-	-
Great blue heron	2	1	10	1	-	-
Whistling swan	-	-	-	-	-	-
Canada goose	465	230	207	28	56	300
Geese/100 river miles	2683	1327	1194	161	326	1730
Mallard	60	215	130	220	-	13
Pintail	-	-	-	-	-	-
Green-winged teal	-	-	-	40	-	-
American wigeon	60	4	-	5	-	-
Redhead	-	-	-	-	-	
Canvasback	-	-	-	-	-	-
Scaup	-	-	-	-	-	-
Goldeneye	-	-	-	-	-	-
Bufflehead	-	-	-	1	-	-
Merganser	6	2	2	-	-	2
Coot	406	5	-	20	-	-
White pelican	-	-	-	-	-	-
Unidentified ducks	-	3	185	11	26	-
Total ducks	126	224	317	277	26	15
Ducks/100 river miles	726	1292	1828	1600	150	87

Table 55. Cont.

Species	Wanapum SEP	OCT	NOV	DEC	JAN	FEB
Loon (sp.)	-	1	-	1	1	2
Grebe (sp.)	-	6	-	-	4	-
Western grebe	10	2	-	-	13	-
Great blue heron	5	4	1	2	2	-
Whistling swan	-	-	-	-	-	-
Canada goose	285	285	423	300	75	759
Geese/100 river miles	742	742	1100	780	195	1980
Mallard	361	6172	5809	174	3561	241
Pintail	-	-	-	-	-	-
Green-winged teal	-	-	-	-	-	-
American wigeon	30	200	-	-	-	20
Redhead	-	-	8	-	300	20
Canvasback	-	-	-	60	107	-
Scaup	-	100	-	50	5	-
Goldeneye	-	-	-	-	-	-
Bufflehead	-	10	-	6	38	8
Merganser	6	3	-	-	25	20
Coot	740	955	355	680	1401	315
White pelican	-	-	-	-	-	-
Unidentified ducks	-	4690	28,770	36,480	187	32
Total ducks	397	11,175	34,587	36,770	4223	341
Ducks/100 river miles	1034	29,100	90,100	95,770	7350	890

Table 55. Cont.

Species	Rock Island SEP	OCT	NOV	DEC	JAN	FEB
Loon (sp.)	-	-	1	1	1	-
Grebe (sp.)	-	-	-	2	1	2
Western grebe	-	-	2	-	-	-
Great blue heron	1	2	1	1	-	-
Whistling swan	-	-	-	-	-	-
Canada goose	128	12	429	275	45	62
Geese/100 river miles	600	57	2045	1290	210	290
Mallard	32	42	14	291	21	73
Pintail	-	-	-	-	-	-
Green-winged teal	-	-	-	-	-	-
American wigeon	11	36	10	-	-	95
Redhead	-	-	-	-	-	105
Canvasback	-	-	-	-	3	-
Scaup	-	-	70	90	59	2
Goldeneye	-	-	-	-	-	-
Bufflehead	-	-	-	5	2	3
Merganser	-	4	5	-	3	5
Coot	-	140	485	440	384	204
White pelican	-	-	-	-	-	-
Unidentified ducks	30	9	-	26	7	-
Total ducks	73	91	99	412	95	283
Ducks/100 river miles	343	430	465	1935	-	-

Table 55. Cont.

Species	Rocky Reach SEP	OCT	NOV	DEC	JAN	FEB
Loon (sp.)	-	-	-	3	3	-
Grebe (sp.)	-	-	4	67	6	-
Western grebe	-	2	2	4	2	-
Great blue heron	1	3	1	2	3	2
Whistling swan	-	3	-	-	-	-
Canada goose	460	1065	609	389	364	157
Geese/100 river miles	1092	2530	1445	923	864	372
Mallard	170	171	116	236	179	82
Pintail	-	-	-	-	-	-
Green-winged teal	-	-	-	-	-	-
American wigeon	18	93	65	51	95	-
Redhead	-	20	50	165	105	29
Canvasback	-	-	-	100	117	38
Scaup	15	283	104	840	794	567
Goldeneye	-	-	-	-	-	-
Bufflehead	-	10	2	48	26	-
Merganser	16	-	-	2	5	-
Coot	490	1674	1831	2731	2711	1518
White pelican	-	-	-	-	-	-
Unidentified ducks	70	449	11	58	87	51
Total ducks	289	1026	348	1500	1408	767
Ducks/100 river miles	686	2436	826	3561	5200	13,870

Table 55. Cont.

Species	Wells SEP	OCT	NOV	DEC	JAN	FEB
Loon (sp.)	2	-	-	-	5	-
Grebe (sp.)	1	4	3	2	2	-
Western grebe	4	5	5	5	-	-
Great blue heron	3	3	5	8	9	-
Whistling swan	-	-	-	-	-	-
Canada goose	650	1122	484	69	113	74
Geese/100 river miles	2290	3950	1700	242	400	260
Mallard	560	258	207	130	23	-
Pintail	-	-	-	-	-	-
Green-winged teal	15	-	-	-	-	-
American wigeon	1280	740	153	237	45	-
Redhead	25	75	14	-	62	26
Canvasback	-	-	23	50	78	30
Scaup	280	350	231	156	35	75
Goldeneye	-	-	-	-	-	-
Bufflehead	-	25	12	-	5	-
Merganser	-	-	-	-	26	29
Coot	1940	5534	5329	5809	4488	734
White pelican	-	-	-	-	-	-
Unidentified ducks	28	1675	1249	910	430	71
Total ducks	2188	3123	1889	1483	704	231
Ducks/100 river miles	7695	11,000	6650	5215	2476	812

Table 55. Cont.

Species	Chief Joseph SEP	OCT	NOV	DEC	JAN	FEB
Loon (sp.)	-	-	-	-	-	-
Grebe (sp.)	-	3	-	-	-	-
Western grebe	-	-	-	-	3	-
Great blue heron	1	1	-	-	-	2
Whistling swan	-	-	-	-	-	-
Canada goose	185	587	659	384	458	280
Geese/100 river miles	360	1132	1270	740	883	540
Mallard	3	602	941	817	155	61
Pintail	-	7	-	-	-	-
Green-winged teal	-	-	-	-	-	-
American wigeon	-	8	-	-	-	-
Redhead	-	-	-	8	-	-
Canvasback	-	-	-	16	-	-
Scaup	-	115	82	-	52	19
Goldeneye	-	-	-	-	-	-
Bufflehead	-	5	8	3	6	-
Merganser	-	14	10	-	4	39
Coot	-	142	455	220	417	187
White pelican	-	-	-	-	-	-
Unidentified ducks	26	-	97	13	181	12
Total ducks	29	751	1138	857	398	131
Ducks/100 river miles	56	1450	2194	1653	767	252

Table 55. Cont.

Species	South FDR SEP	OCT	NOV	DEC	JAN	FEB[a]
Loon (sp.)	-	2	-	-	-	-
Grebe (sp.)	-	33	-	-	-	-
Western grebe	-	4	-	-	-	-
Great blue heron	1	1	-	-	-	-
Whistling swan	-	-	-	-	-	-
Canada goose	40	372	404	140	-	-
Geese/100 river miles	86	800	866	300	-	-
Mallard	-	63	59	-	11	-
Pintail	-	-	-	-	-	-
Green-winged teal	-	-	-	-	-	-
American wigeon	-	35	40	9	-	-
Redhead	-	-	-	-	-	-
Canvasback	-	-	-	-	-	-
Scaup	-	11	-	-	-	-
Goldeneye	-	-	-	-	-	-
Bufflehead	-	-	-	-	2	-
Merganser	-	1	8	-	1	-
Coot	-	-	-	-	8	-
White pelican	-	-	-	-	-	-
Unidentified ducks	2	10	79	-	-	-
Total ducks	2	120	186	9	14	-
Ducks/100 river miles	4	257	1264	319	30	-

Table 55. Cont.

Species	North FDR SEP	OCT	NOV	DEC	JAN[a]	FEB[a]
Loon (sp.)	-	1	1	-	-	-
Grebe (sp.)	-	35	88	14	-	-
Western grebe	-	30	12	2	-	-
Great blue heron	1	2	-	-	-	-
Whistling swan	-	-	-	-	-	-
Canada goose	325	750	574	-	-	-
Geese/100 river miles	307	708	542	-	-	-
Mallard	6	410	501	168	-	-
Pintail	-	-	-	-	-	-
Green-winged teal	-	-	-	-	-	-
American wigeon	-	20	25	-	-	-
Redhead	-	-	-	-	-	-
Canvasback	-	-	-	-	-	-
Scaup	-	-	114	-	-	-
Goldeneye	-	-	-	3	-	-
Bufflehead	-	18	15	1	-	-
Merganser	21	11	48	-	-	-
Coot	-	-	21	-	-	-
White pelican	-	-	-	-	-	-
Unidentified ducks	62	91	207	40	-	-
Total ducks	89	550	910	212	-	-
Ducks/100 river miles	82	510	843	200	-	-

[a]Not censused.

were in small groups along the banks, with no fewer than 10 ducks on any 5-mile section.

The diving ducks showed a more even distribution with an average of 14.8 ducks (range 3-37 per 5 miles). Diving ducks were least abundant where the concentrations of dabbling ducks were located.

Canada Geese demonstrated a discontinuous distribution, being present in only five of the ten 5-mile sections. We found 260 (68 percent) of the geese between RM 485 and 487 where they were foraging on the right bank below the Vernita Bridge. Other geese were on the water or on the cobble beaches of islands at these locations: RM 345-350, 365-370, 370-375 and 375-380.

Along the Priest Rapids segment there are two areas of high wintering waterfowl concentration. Just upstream from the dam at RM 397.5 is Goose Island, surrounded by shallow water. This area held 180 (65 percent) of the 277 dabbling ducks counted. The remainder of the ducks were distributed evenly along the shoreline.

Only 28 Canada geese were counted during the December census and these were in small groups along the shoreline. In other months when more geese were present, there is a concentration of geese on the agricultural fields at RM 405-410. In February, 280 geese were counted in this area with the remaining 20 around Goose Island.

The largest concentration of waterfowl encountered along the upper Columbia River is on Wanapum Pool in the 10 mile section from Wanapum Dam to above the Vantage Bridge (RM 415-425). Over 21,000 (58 percent) of the 36,770 ducks on Wanapum pool were present there at Vantage. The next three 5-mile sections which run through the steep basalt cliffs held 8850 (24 percent), 3500 (10 percent), and 2575 (7 percent) ducks, respectively, with very few ducks seen on the last 15 miles of river up to Rock Island Dam.

During December, geese were seen in only two locations upstream from Crescent Bar RM (440-445) where 273 (91 percent) of the total 300 were found with the remaining 26 at RM 451.

Rock Island pool is the oldest in the upper Columbia River. It also is the only segment with substantial industrial development. There are no special areas of waterfowl concentration on this pool, although ducks and geese did not appear to avoid the area of greatest industrial development (RM 452-460). At the time of the censuses in months other than December there were relatively few dabbling ducks in relation to diving ducks (Scaup and Redhead) and in all censuses the number of Coots outnumbered ducks. The overall density of ducks per 100 river miles was the lowest on this pool, with the exception of the two northern segments, Rufus

Woods and FDR, where the colder climate probably explains the scarcity of ducks.

Along most of Rocky Reach Pool the river runs through a deep valley with very little flat grassland or agricultural land directly adjacent to the river. Perhaps this explains the relatively few dabbling ducks found there. Only 236 (16 percent) of the 1500 ducks were Mallards and 154 (65 percent) of the Mallards were between Rocky Reach Dam and Turtle Rock Island (RM 475).

The diving ducks and Coots were scattered quite evenly along the shoreline with no large concentrations in any one 5-mile section.

Canada Geese occurred in only four of the eight 5-mile sections: RM 475-480 (75 geese), RM 485-490 (207 geese), RM 490-495 (75 geese), and RM 495-500 (30 geese). These areas support agricultural fields in the valley bottom, suggesting a correlation of wintering geese with agricultural fields.

Winter waterfowl populations on Wells Pool are concentrated at RM 527-540. This includes the wide expanse of shallow water at the mouth of the Okanogan River above the highway bridge at Brewster. In all months the Mallards and Wigeon were found almost exclusively within this area but while the diving ducks, Scaup, Redhead, etc., were in large flocks here they were also rather evenly distributed throughout the length of Wells Pool.

The geese on Wells Pool in December were in two flocks -- one of 30 just below the bridge at Brewster and the other of 40 toward the middle of the segment at RM 535. In October when 1122 geese were counted, 980 (87 percent) were at the mouth of the Okanagon River with the remainder just above Pateros at RM 525.

The distribution of ducks along Rufus Woods Lake was uneven and discontinuous during the December count. More than 10 ducks were counted in only four of the 11 5-mile sections. Of 857 ducks counted, 536 (63 percent) were located between RM 568 and 572 where the river makes a sharp bend and there are agricultural fields close to the river. Forty more ducks were counted between RM 555 and 560. This section also held the greatest diversity of ducks, with each of the 5 species identified on Rufus Woods Lake being present here.

The other large concentration of ducks (135) was between the dam and RM 550. This area also held all of the 220 Coots and 290 (78 percent) of the Canada Geese. Other geese were counted at RM 569 (60) and RM 555-560 (20) areas in which ducks were also counted.

By December the waterfowl populations on FDR were very small. Instead of using the December census the October data will be used to illustrate the distribution of waterfowl on FDR.

The occurrence of ducks along FDR is limited almost exclusively to the small coves and shallow waters around islands, but not all such areas held ducks.

The distribution of geese along FDR showed a pattern similar to that observed on Rufus Woods Lake. In almost all cases, the flocks of geese were found in areas where there is flat agricultural land. Exceptions to this were at Hawk Creek (RM 633), the Spokane River (RM 645), upstream from the Kettle River at RM 710 where there is extensive protected shallow water and at RM 738 -- another area of protected shallow water.

Seasonal Abundance of Waterfowl

The wintering waterfowl populations on the upper Columbia River are not stationary but move along the river. Over the period covered by our censuses (September - February), waterfowl are generally moving southward in response to advancing winter conditions. These censuses do not cover the early spring when the birds are returning northward.

A complete analysis of river utilization by waterfowl over the fall and winter months would require more information on the movement of birds into and out of other wintering areas adjacent to the Columbia River. Examination of Figures 2 through 5 shows some seasonal pattern in the use of the upper Columbia River by ducks and geese.

The total number of ducks on the upper Columbia River increased from September, to a peak in November and December and then declined in January and February (Figure 6). Each of the individual river segments shows a different pattern of population fluctuations, although only Rock Island and Rocky Reach demonstrate a significantly different pattern (Figure 2). Three of the segments, Hanford, Wanapum and Wells, appear to be most important to fall and winter duck populations, although after September, Wells declines in importance (Figure 2).

Early in the fall there are relatively few ducks present on the upper Columbia River with 64 percent of these being present on Wells and most of these at the mouth of the Okanogan River. In October there is a shift southward to Wanapum and Hanford with 48 percent and 27 percent of the total respectively. During November and December, Wanapum accounted for 63 percent and 62 percent of the total and Wanapum and Hanford combined held 91 percent and 92 percent of the total. In January Hanford and Wanapum combined, still accounted for 89 percent of the total but the total for Hanford was up to 72 percent.

Then in February the majority (59 percent) of the 4,285 ducks were on Hanford with the remainder scattered rather evenly among the other segments.

Goose counts through the fall for the whole study area give these rough totals: September 2700; October 4500; November 4600; December 1900; January 2900; and February 2800. From this one could conjecture that there is a resident population of about 2800 birds, and a migratory passage of another 1500-2000. However, there are as yet no studies of marked individuals to test this hypothesis.

Compared with ducks, Canada Geese showed a somewhat different movement pattern, suggesting that geese are responding to the advancing winter in a different manner. Except for October and November when the number of geese reached a maximum, the monthly totals remained about the same. Unlike the ducks, geese were distributed more evenly among the segments until January and February when the geese had shifted southward with 61 percent and 42 percent being present on Hanford.

In contrast to the geese, the ducks exhibit a very large migration passing through the study region. Twenty-thousand new ducks appear in October. There are two possible sources of these birds -- Canada and the smaller bodies of water in the Columbia Plateau. Birds could be driven from the Columbia Plateau by the opening of the hunting season in mid-October.

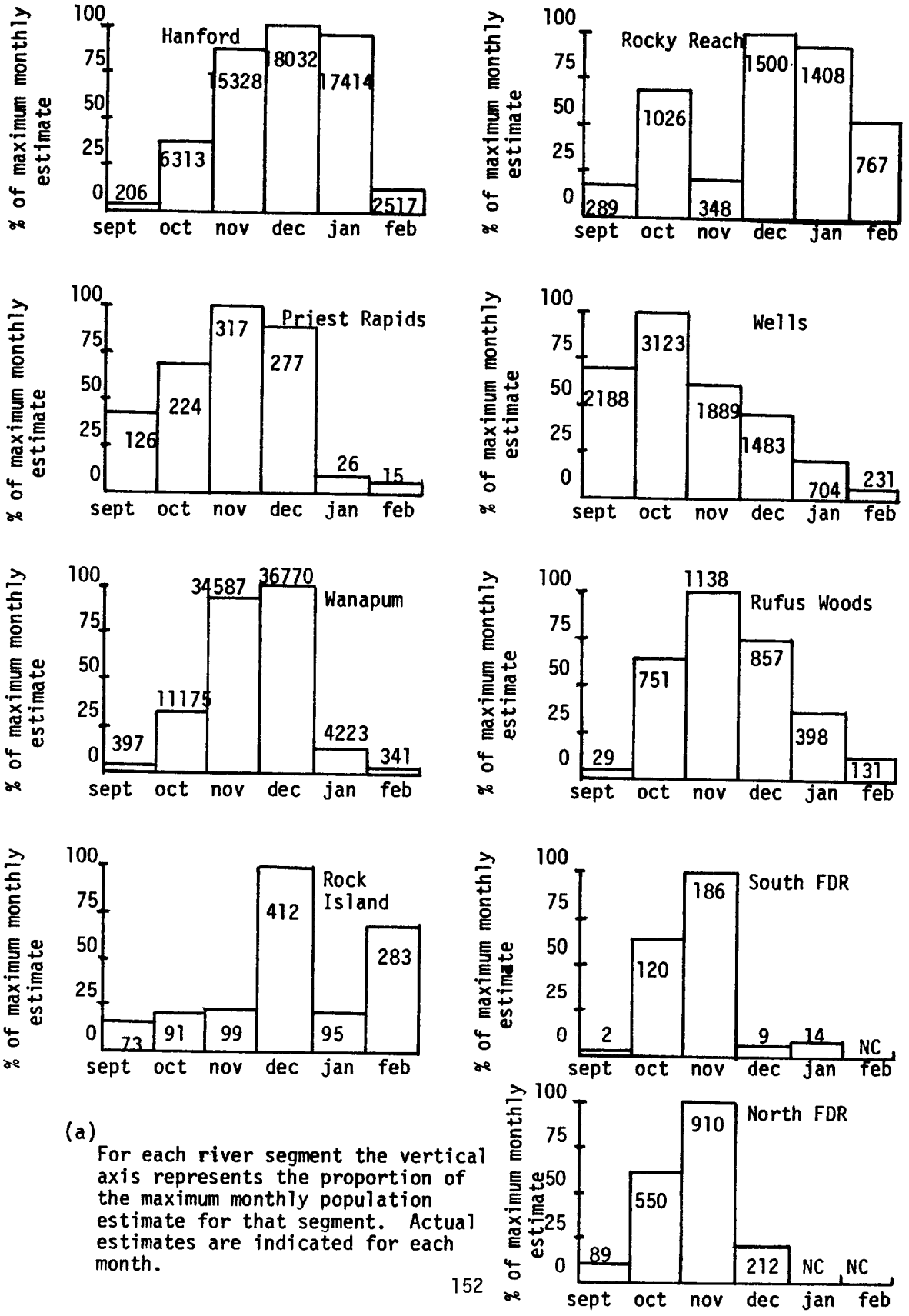
In November the river population has increased by another 30,000, presumably northern migrants. December counts are the highest of all, totalling about 60,000 ducks. In January only about 24,000 remain and in February only about 4000.

In earlier years more ducks were counted on the river. The eight year mean maximum for winter 1961-69 on the Hanford segment is 250,000 ducks. This is four times the number of ducks now using the total study area. One might speculate that the great increase of irrigation within the Columbia Basin has provided more wintering range than was available previously. If these ducks are really spread out in this new habitat, the suggestion above that hunting drives ducks to the river is probably not true.

From these crude figures it would seem clear that the study area serves as a major duck resting habitat during the hunting season, but that as far as production is concerned, it is more important for geese than for ducks.

There are no comparable data available for spring and summer abundances of waterfowl. No flights were made during these seasons and no other quantitative data were collected. These lists in Table 58 were compiled from the supplemental observations and

Figure 1. Relative monthly abundance [a] of ducks by river segment for the upper Columbia River, September 1974-February 1975. (NC= not censused)



(a) For each river segment the vertical axis represents the proportion of the maximum monthly population estimate for that segment. Actual estimates are indicated for each month.

Figure 2. Monthly proportion of total number of ducks on upper Columbia River counted on each river segment, September 1974-February 1975. (NC= not censused)

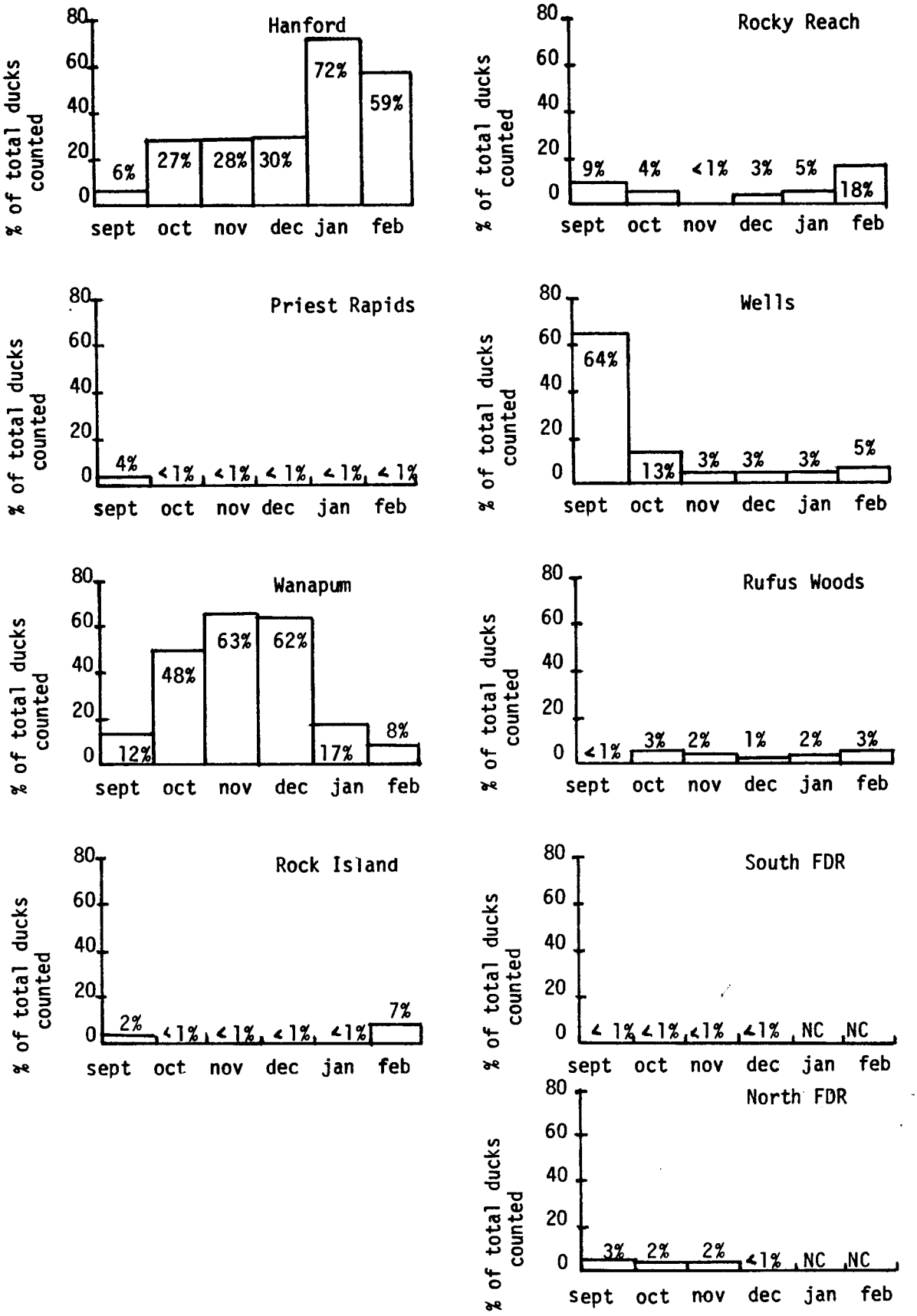
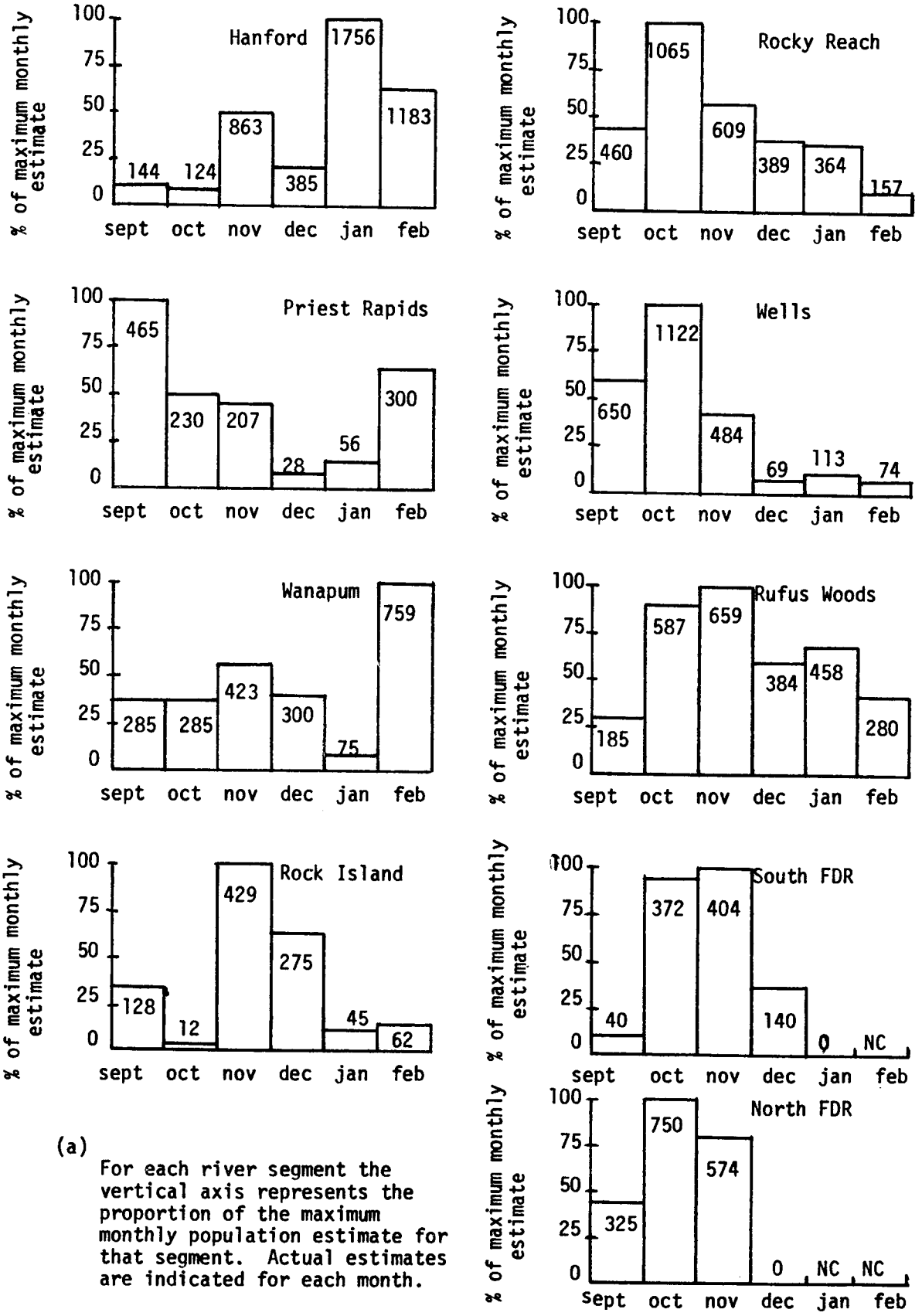


Figure 3. Relative monthly abundance [(a)] of Canada Geese by river segment for the upper Columbia River, September 1974-February 1975. (NC= not censused)



(a) For each river segment the vertical axis represents the proportion of the maximum monthly population estimate for that segment. Actual estimates are indicated for each month.

Figure 4. Proportion of total number of Canada Geese on upper Columbia River counted on each river segment, September 1974-February 1975. (NC= not censused)

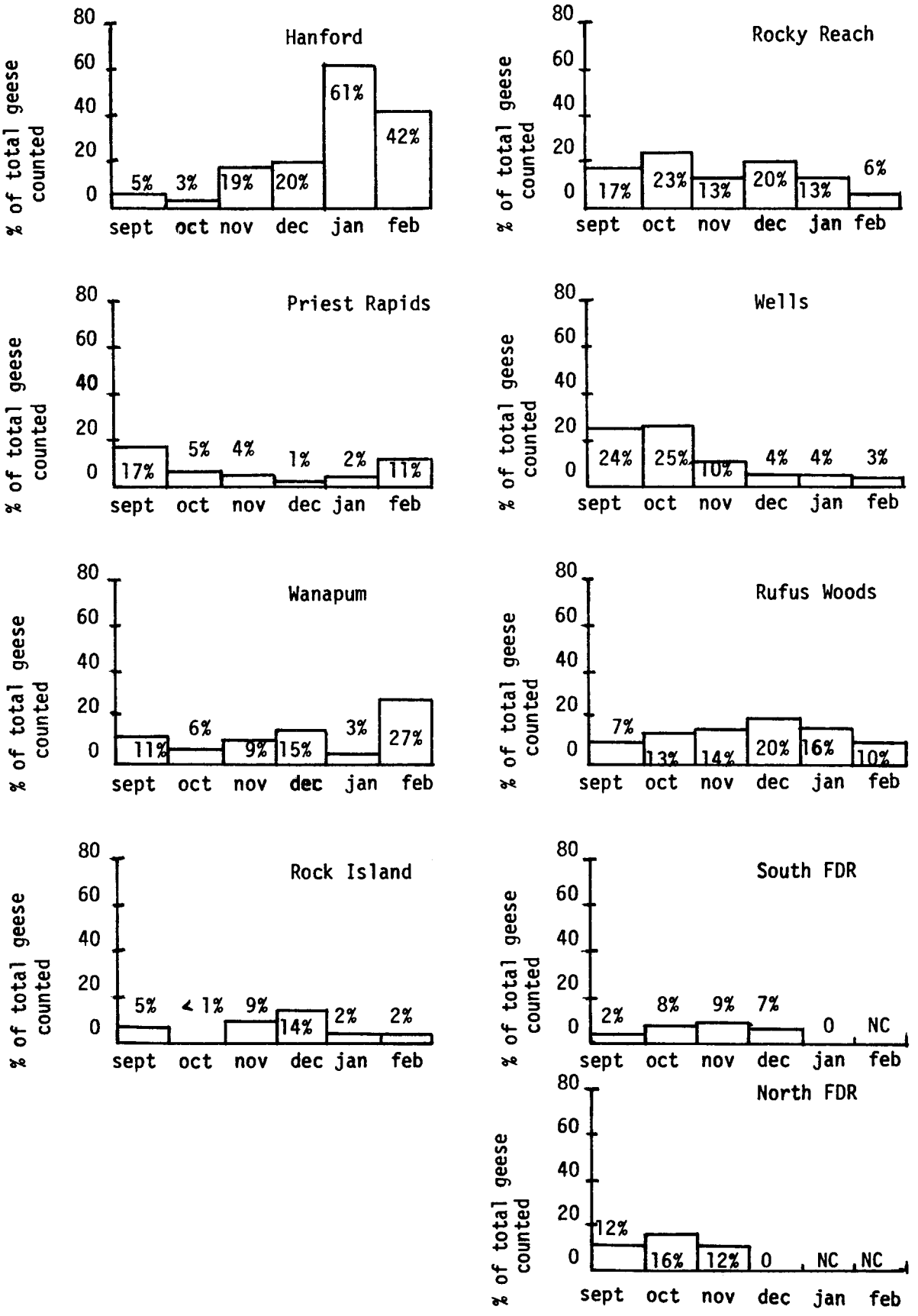


Figure 5. Monthly estimates of ducks present on the upper Columbia River, September 1974-February 1975.

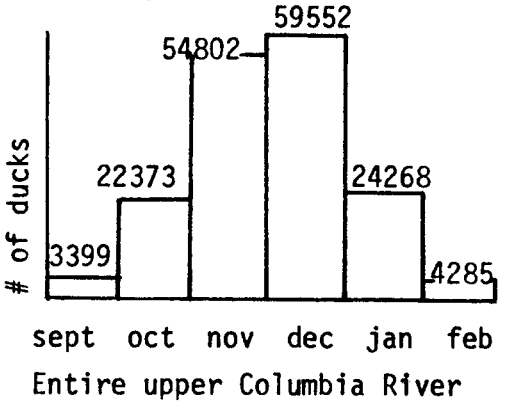
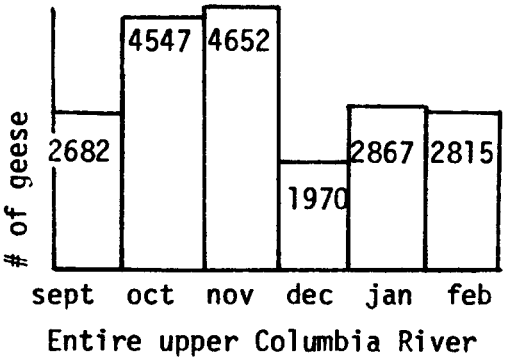


Figure 6. Monthly estimates of geese present on the upper Columbia River, September 1974-February 1975.



Species identified on the boat transects, as well as the aerial flights and reports from other observers.

A total of 37 water bird species were observed (Appendix N) for all seasons combined along the river.

There appear to be no differences in numbers of species among the river segments except for Rufus Woods and South FDR with only 16 and 17 species, respectively, compared with 20-25 on each of the other segments. Part of this difference is due to the limited amount of time spent on these two areas, but it may also be indicative of the reduced diversity of habitat along the river banks on Rufus Woods and South FDR.

On all the segments the number of species present is greatest during the spring and fall migration and throughout the winter. Very few species seem to be summer residents along the upper Columbia River.

Furbearers

We recorded 10 species of furbearers occurring in the study area (see Table 45). In addition, one lynx trapped near Grand Coulee, was reported by the Washington Department of Game in their fur harvest report for 1973-74 (Table 48).

Coyotes and raccoons were the most commonly observed furbearers, recorded for every segment, except Priest Rapids for raccoon. We observed only one set of bobcat tracks – along Priest Rapids pool and off the transects. However, bobcats were reported harvested along the Wanapum, Rock Island, Rocky Reach, Wells, and South FDR segments (Table 8). Although river otter have not been reported in the Washington Department of Game fur harvest reports for the upper Columbia in the past 3 years (Table 8), we recorded their occurrence in four segments – Wanapum, Wells, Rufus Woods Lake, and North FDR (Table 51). We recorded mink sign along the Hanford, Priest Rapids, Rock Island, Wells, North FDR, and British Columbia segments. We observed muskrat sign along only Rock Island pool, although they were reported harvested from Hanford, Rock Island, Wanapum and/or Rocky Reach pools, and Wells and/or Rufus Woods Lake (Table 8). No weasels entered our traps, but we observed weasel tracks along South FDR, and saw one long-tailed weasel along North FDR. Four weasels were reported harvested along Rocky Reach pool in 1972-73 (Table 8). Badger were recorded along the Hanford, Priest Rapids, Rufus Woods Lake, and South FDR transects and skunk along all segments from Rock Island north except the British Columbia segment.

We recorded beaver for the Hanford, Wanapum, Wells, Rufus Woods Lake, South FDR, North FDR, and British Columbia segments (Table 51). Only one lodge, located on the right bank of the Okanagan River

near the mouth, was observed. We observed old beaver sign on one grazed cottonwood transect near Northport, where cottonwoods 20 cm dbh had been felled. Harvest records indicate beaver taken possibly from the Hanford segment, somewhere between Wanapum and Grand Coulee dams, and South FDR. Deciduous shrubs and trees, used particularly as winter food by beaver, are in limited supply along the upper Columbia River (see Tables 9 and 10). Many of the small pockets of this riparian habitat contain beaver cuttings. This situation probably supports a very small and very mobile beaver population. The population may be further limited by lack of a controlled water level, which beaver generally require for lodge and bank burrow habitation.

Scent stations attracted raccoons, coyotes, porcupines, and red squirrels, mostly. However, several times scent posts failed to attract coyotes in areas where we had heard coyotes howling the previous night. Coyote sign occurred on 33% of the riparian shrub steppe transects (Table 45). Raccoon sign occurred on 8% of the riparian shrub, 28% of the riparian tree, 42% of the conifer, and 26% of the shrub steppe transects. Badger burrows occurred only on the drier transect – 50% (1) of the grassland and 32% of the shrub steppe transects. Skunk sign occurred only on 11% of the riparian and 11% of the shrub steppe transects. Mink showed a preference for riparian areas, their sign occurring on 25% of the riparian shrub, 42% of the riparian tree, 8% of the conifer, and 16% of the shrub steppe transects.

Our records (Table 45) and those from the Washington Department of Game (Table 8) indicate the upper Columbia River in its present form supports a very low furbearer population. This situation correlates with the sparse riparian development of the area (see Tables 9 and 10) and probably is influenced by it.

Birds of Prey

The raptorial birds observed in the study region are:

Turkey Vulture
Eagles: Bald, Golden
Buteonid Hawks: Red-tailed, Swainson's, Rough-legged, Ferruginous
Accipiters: Cooper's Hawk, Sharp-shinned Hawk, Goshawk
Falcons: Prairie, American Kestrel
Osprey
Marsh Hawk
Owls: Long-eared, Short-eared, Great Horned, Burrowing, Barn

Information on birds of prey, (vultures, hawks, eagles, osprey, and owls) along the upper Columbia River is primarily from supplemental observations. These observations are summarized in Table . In

addition to presenting the list of species observed, an estimate of the total number of different individuals sighted on each segment for each season is given in Table 56. This number is based on the maximum number of individuals counted on a single day within a particular section of river, and is dependent not only on the actual number of birds present but also on the observer and time spent in an area. Because the observers involved and time spent was variable among the segments and by season, this number is presented only to show the relative species abundance.

Bald Eagles received more intensive census effort during the fall and winter months. Because they are quite conspicuous they could be readily counted during the monthly flights for waterfowl censuses. These counts are given in Table 57.

The nests of 10 different raptors were located during the springs of 1974 and 1975 (Table 58).

A total of 19 different birds of prey (Table 59) was observed along the upper Columbia River. Of these 10 are included in the list of endangered species (Table 72).

The Hanford segment supported the most diverse (14 species) raptor community and also the greatest total apparent number of individuals (Table 56). This is probably due to the largely undeveloped nature of the Hanford Reservation.

Of the 19 species of birds of prey encountered, only the Bald Eagle and Osprey have a direct and obvious relationship with the river, preying as they do on fish from the river. Osprey are uncommon at all seasons along the river. In 1975, however, 3 nests were located in trees in the vicinity of Northport. Bald Eagles were uncommon along the river during the summer and into the fall. There is a wintering population along the river which reaches a maximum in January and February when 29 and 38 individuals were counted during the aerial censuses.

The presence of birds of prey other than the Osprey and Bald Eagle is only indirectly influenced by the condition of the river. In general there are two features along the river which are of special importance -- the cliffs and groves of larger trees on the banks of the river. Both of these features have been created by the interaction of the flowing water with the geologic substrate. Cliff sites were created over geologic time by the effects of major geological events and the erosive action of the river. These rock cliffs, basalt along most of the river, and some limestone near the Canadian border are quite secure and unlikely to be influenced to any great extent by the pattern of river regulation. The one exception is the less stable clay cliffs on the Hanford segment which are more susceptible to erosion and slides.

Cliff areas are used as nest sites and roosts, and the continued utilization of these features will be largely influenced by the prey populations on the adjacent lands. On the Hanford segment the continued erosion and slide action affects the configuration of the cliff faces which changes the suitability of these sites for nesting activity.

The interaction of the river with the geological substrate has also created the conditions necessary for the establishment and growth of the trees which are used for nesting and roosting. In the southern portion of the study area the trees used by the raptors are the cottonwoods and the introduced locusts. Further north where ponderosa pine is present along the river these trees are utilized along with the cottonwood and locust. The continued survival and regeneration of those trees will be influenced by the pattern of river regulation. Except for the northernmost portion of the study area, the distribution of trees is largely limited to the banks of water courses, although in recent times, irrigation has expanded tree distribution. Thus the larger trees favored by many of the birds of prey as nest sites and roosts are limited in number and distribution. Those trees found along the river are thus of considerable importance.

There seems little doubt that in the southern part of the study area there is a real shortage of nesting trees.

Trees can be grown along the shores of the Columbia. Trees are an important habitat component for a great many sorts of wildlife, not only raptorial birds but Great Blue Herons, woodpeckers, and a host of other birds and mammals which seek shelter in holes. Therefore the establishment of trees might well be considered in any management plan for the riparian zone.

Other Birds

Ring-billed, Herring and California gulls and Forster's Tern were found in this study. During the late fall and winter, California, Ring-billed and Herring gulls are distributed throughout the upper Columbia River. The wintering populations are predominantly immature birds. No large concentrations of gulls were observed. Instead the birds were seen singly or in groups of less than ten.

Four gull colonies were found in the springs of 1974 and 1975, all of which were on Priest Rapids and the Hanford segments (Table 60). The island at RM 398 on Priest Rapids supported a Forster's Tern colony, the only tern nesting observed, as well as a Ring-billed Gull colony.

Although the only gull nesting colonies found were in the southernmost two segments of the study area, gulls were found throughout the length of the river during the summer months. Ring-billed Gulls were the most common in all areas in summer, and Herring Gulls were not recorded at that season.

Table 56. Seasonal occurrence of hawks, eagles and owls along the upper Columbia River 1974-1975. (The spring list includes observations for 1974 and 1975).[a]

	Hanford			
	Sp	Su	F	W
Cooper's hawk	-	-	F (1)	-
Red-tailed hawk	Sp (6)	Su	F (2)	W (12)
Swainson's hawk	-	-	F (1)	-
Rough-legged hawk	-	-	F (1)	-
Golden eagle	-	-	F[a](1)	-
Bald eagle	Sp	-	F[a]	W[a]
Marsh hawk	Sp (3)	Su	F (2)	W (3)
Osprey	Sp (2)	-	F (1)	-
Prairie falcon	-	-	F (1)	-
American kestrel	Sp (5)	Su	F (10)	W (7)
Great horned owl	Sp (4 pr)	Su	F	W (10)
Burrowing owl	Sp (1 pr)	S	-	-
Short-eared owl	-	-	-	W (2)
Barn owl	-	-	F (1)	-

	Priest Rapids			
	Sp	Su	F	W
Red-tailed hawk	Sp (2)	Su	-	-
Golden eagle	Sp (1)	-	-	-
Bald eagle	-	-	F[a]	W[a]
Marsh hawk	Sp (1 pr)	-	F (1)	-
Prairie falcon	Sp (1)	-	-	-
American kestrel	Sp (2)	Su	F (2)	W (1)
Long-eared owl	Sp (1)	-	-	-
Short-eared owl	-	-	-	W (2)

	Wanapum			
	Sp	Su	F	W
Turkey vulture	Sp (2)	Su (1)	-	-
Red-tailed hawk	Sp (2)	Su	-	-
Golden eagle	Sp (1)	-	-	-
Bald eagle	-	-	-[a]	W[a]
Prairie falcon	Sp (3 pr)	Su	-	-
American kestrel	Sp (3 pr)	Su	F (5)	-

Table 56. Cont.

	Rock Island			
	Sp	Su	F	W
Red-tailed hawk	Sp (4)	Su	-	-
Cooper's hawk	-	-	F_a(1)	-
Bald eagle	-	-	-	W^a
Osprey	Sp (1)	-	-	-
American kestrel	-	-	F (3)	W (1)

	Rocky Reach			
	Sp	Su	F	W
Red-tailed hawk	Sp (1)	Su (1)	-	-
Sharp-shinned hawk	-	-	-	W_a(1)
Bald eagle	-	-	F^a	W^a
Marsh hawk	-	-	F (1)	-
Osprey	-	Su (1)	F (1)	-
Long-eared owl	-	-	-	W (1)
Short-eared owl	-	Su (1)	-	W (1 pr)

	Wells			
	Sp	Su	F	W
Red-tailed hawk	Sp (1 pr)	Su	F (1)	-
Sharp-shinned hawk	-	-	F_a(1)	-
Bald eagle	-	-	F^a	W^a
Marsh hawk	-	-	F (1)	W (1)
American kestrel	-	Su (1)	-	-
Great horned owl	-	-	-	W (1 pr)

Table 56. Cont.

	Rufus Woods Lake			
	Sp	Su	F	W
Turkey vulture	Sp (1)	-	-	-
Red-tailed hawk	Sp (2 pr)	Su	F (1)	W (2)
Sharp-shinned hawk	-	-	F (1)	-
Ferruginous hawk	Sp	-	-	-
Golden eagle	Sp (1 pr)	Su	-	-
Bald eagle	-	-	-[a]	W[a]
Marsh hawk	-	-	-	W (1)
American kestrel	Sp (3)	-	-	-

	South FDR			
	Sp	Su	F	W
Turkey vulture	Sp (1)	-	F (1)	-
Red-tailed hawk	Sp (2)	-	F (1)	W (1)
Golden eagle	-	Su (2)	F (1)	-
Bald eagle	-	-	F[a]	W[a]
Marsh hawk	-	-	-	W (1)
Osprey	-	Su (3)	-	-
Great horned owl	-	-	F (1 pr)	-

	North FDR			
	Sp	Su	F	W
Turkey vulture	Sp (2)	Su (6)	-	-
Red-tailed hawk	Sp (1)	Su (2)	F (1)	W (1)
Cooper's hawk	-	Su (1)	-	-
Goshawk	-	-	F (1)	-
Swainson's hawk	-	Su (1)	-	-
Golden eagle	-	-	F (2)	W (2)
Bald eagle	Sp	-	F[a]	W[a]
Osprey	Sp (2 pr)	Su	F (1)	-
American kestrel	Sp (2)	Su (3)	-	-
Long-eared owl	-	-	-	W (1)

[a]Numbers in parentheses indicate the best estimate of the maximum number of different individuals sighted. See text for explanation.

[b]See Table 62 for counts of bald eagles made during aerial waterfowl censuses.

Table 57. Aerial counts of Bald Eagles along the upper Columbia River Oct. 1974-April 1975.

Segment	River mile	OCT	NOV	DEC	JAN	FEB	APR
Hanford		1 imm	1 imm	1 imm	4 imm	1 imm	
	360-375	1 ad	2 ad	6 ad	2 ad		
				1 imm			
	385-395			1 ad	1 ad		
Priest Rapids	400		2 imm	1 imm		1 ad	
	410-415						
Wanapum	420-425					1 ad	
	430-435			2 ad	1 ad		
Rock Island							
Rocky Reach	475-480				2 ad	1 ad	
	485-495		1 ad		3 ad		
				1 imm	2 imm		
	510-520				2 ad	1 ad	
Wells	530-540			2 ad	5 ad	2 ad	
						5 imm	
Rufus Woods	555-560				1 ad	2 ad	
					1 imm		
	570-580					4 ad	
	580-595	1 ad		3 ad	4 ad	3 ad	
						5 imm	
South FDR	605-615					3 imm	3 ad
	630-640	2 ad	1 ad		1 ad		
North FDR	655-680			3 ad		1 ad	
						1 imm	
	700-710		1 ad			2 ad	1 imm
						4 imm	
	725-730		2 ad			1 ad	
	735-740	1 ad					
TOTALS		1 imm	3 imm	3 imm	7 imm	19 imm	1 imm
		5 ad	7 ad	17 ad	22 ad	19 ad	3 ad

Table 58. Raptor nests located along the upper Columbia River during springs of 1974 and 1975.

	1974
Hanford Reservation	Kestrel 1 nest (cliff) Red-tailed hawk 1 nest (tree)
Priest Rapids	Prairie falcon 2 nests (cliff)
Wanapum	Prairie falcon 3 nests (cliff) Red-tailed hawk 1 nest (cliff) Kestrel 3 nests (cliff) Turkey vulture 1 nest (cliff)
Rock Island	
Wells	Red-tailed hawk 1 nest (tree)
Chief Joseph	Red-tailed hawk 2 nests (tree) Golden eagle 1 nest (tree)
North FDR	Osprey 2 nests (tree) Bald eagle 1 nest (tree)
	1975
Hanford Reservation	355-360 LB Red-tailed hawk 4 nests (tree) Burrowing owl 1 nest (cliff) Great horned owl 2 nests (tree) 370 LB Great horned owl 1 nest (tree) 370 RB Great horned owl 1 nest (tree Red-tailed hawk 1 nest (tree)
Priest Rapids	400 island Marsh hawk 1 nest
Wanapum	
Rock Island	470.5 LB Red-tailed hawk 1 nest (tree)
Wells	Okanogan River LB Red-tailed hawk 1 nest (tree)
Chief Joseph	571 LB Golden eagle 1 nest (tree)
North FDR	651.5 LB Osprey 1 nest (tree) 741.5 LB Osprey 2 nests (tree)

Table 59. Occurrence of birds of prey by river segment along the upper Columbia River. Observations for all seasons (1974-1975) have been combined in this list. Species identified with an asterisk are included in the list of rare and endangered species (Table 70).

	Hanford	Priest Rapids	Wanapum	Rock Island	Rocky Reach	Wells	Rufus Woods	South FDR	North FDR
Turkey vulture			X				X	X	X
Goshawk									X
Sharp-shinned hawk*					X	X	X		
Cooper's hawk*	X			X					X
Red-tailed hawk	X	X	X	X	X	X	X	X	X
Swainson's hawk*	X								X
Rough-legged hawk	X						X		
Ferruginous hawk*							X	X	X
Golden eagle	X	X	X				X	X	X
Bald eagle	X	X	X	X	X	X	X	X	X
Marsh hawk*	X	X			X	X	X	X	
Osprey*	X			X	X			X	X
Prairie falcon*	X	X	X						
American kestrel*	X	X	X	X		X	X		X
Great horned owl	X					X		X	
Burrowing owl*	X								
Long-eared owl		X			X				X
Short-eared owl	X	X			X				
Barn owl*	X								
Total species	14	8	6	6	7	6	8	7	10

Table 60. Locations and population estimates of gull, tern and heron colonies along the upper Columbia River during 1974 and 1975.

Location	Species and population estimate		
586.5 LB	Great blue heron rookery	3-5 pairs	
413 Island	Gull colony	Ring-billed gulls	120 individuals
		California gulls	30 individuals
398 Island	Gull colony	Ring-billed gulls	250 individuals
		Forster's terns	100 individuals
370 RB	Great blue heron rookery		100 pairs
372 Island	Black-crowned night heron rookery		20 pairs (1974)
344 Island 18	Gull colony	Ring-billed gulls	1500 individuals
342 Island 19	Gull colony	Ring-billed gulls	2000 individuals

The Great Blue and Black-crowned Night herons were the only herons found along the river. Rookeries of both species were located.

A Black-crowned Night Heron rookery containing approximately 20 pairs was observed in 1974 on Locke Island. This rookery was located in mulberry trees at the edge of the island where the bank is subject to erosion. On this island there are now two mulberry clumps, both of which are subject to erosion and both of which will soon fall over the bank at the current rate of erosion. There are very few similar tree clumps in the vicinity for the Black-crowned Night Herons to move into.

Great Blue Herons are present on the southern segments throughout the year with the greatest number being present on Hanford. See Table 58 for the record of Great Blue Herons counted during the aerial censuses.

Two Great Blue Heron rookeries were located, one on Rufus Woods Lake in ponderosa pine along the 4-mile free-flowing section just below Grand Coulee Dam and another in a cottonwood grove on Hanford. The Rufus Woods Lake rookery contained only 3-5 pairs while the Hanford rookery contained approximately 100 pairs. There is concern about the continued existence of this rookery. It is well-protected from human disturbance but natural factors are causing a degradation of the site. These include large amounts of heron excreta and damage by beavers and porcupines. No other large cottonwood stands exist along that segment of the river. There are several groups of large locust trees which might serve as a substitute if and when the presently occupied cottonwood grove collapses.

However, there seems little doubt that an increase in shoreline trees would serve to maintain present heron populations and probably encourage their increase.

The small land birds received the most intensive census treatment of the bird groups studied. These birds were censused on transects laid out parallel to the river using the techniques outlined in the study proposal with modifications as described below.

For the summer census period, the walk-through technique was used in the open habitats while those transects in riparian shrub and tree habitats were censused by the station technique and the censuses were conducted during the early morning hours from sunrise until about 10:00 a.m. During the fall and winter field seasons, when the birds are not territorial and many species are moving in flocks, the walk-through technique was used on all transects.

The calculation of densities of birds on the transects is made difficult by differences in the detectability of the various species encountered. This makes it difficult to assign an appropriate area measure which accurately represents the size of the area actually censused. The Oregon team handled this problem by determining a detectability factor for each species based on the distance at which individuals were detected. The Washington team did not measure these distances and instead, for the purpose of calculating densities, the area covered was calculated from the width and length of the transect. Where there was an obvious edge to the habitat the width was taken as the width of the habitat along the transect. On other transects the width was taken as 30 m on either side of the transect line for a total width of 60 m. Calculated density values are based on the assumption that most of the birds within that strip were detected.

There was considerable variation in the numbers of birds counted on the two census days for each transect. For the fall and winter periods when the birds are not territorial and most species are moving over large areas, the number of birds present is given as the average of the two days. In the summer when most species are territorial the number of individuals of each species is taken as the maximum number counted on either day. Thus, if two Robins were observed the first day and only one on the second day, the number used in the calculation of Robin density is two.

The original study plan called for censuses to be conducted during the spring migration. These censuses were initiated on the Hanford segment in April but at that time the spring migration had not commenced. Thus, we did not continue the effort. The time schedule did not allow for rescheduling the spring census so we have no data for this season.

The calculated density values are given in Appendix 15 where the transects covering similar habitats within each segment are presented together. Also included in Appendix L are the total number of individuals of all species, the total number of species and the diversity index (D.I. = $-\Sigma$ pi ln pi) for each transect. Larger species such as hawks, owls, and waterfowl which were observed on the transects are included in Appendix P but have not been included in the totals.

Percent frequency of occurrence of species on transects is given in Apendix Q for the summer data and Appendix R for fall and winter.

Because most species exhibit low frequencies within the habitat types, average densities by habitat type have not been calculated.

Passerine birds nest in the region and, equally important, use it as a migratory pathway both spring and fall. These migrating species must rest, feed, and find protection during their movements, so shoreline conditions have important consequences for them. Our study of the various transects shows that the more ecologically complex the plant community, the more different species of birds use it, both for breeding and during migration. The riparian shrub and riparian tree plant communities are at the top of the habitat quality list. Therefore it is clear that a managerial plan favoring the development of woody riparian vegetation would favor many passerine birds.

The results of the transect censuses indicate that the bird communities are responding to finer distinctions among habitat types than were used in developing the groupings used in this report. It is likely that the nature of the surrounding habitat in regulating the presence or absence of a particular species is as important as the habitat on the transect itself. Desert shrub Transect 4 in section A, for instance, supports quite a different bird community than the other desert shrub transects. The most obvious explanation for this difference is to be found in its location along a slough and its close proximity to a large grove of locust trees. A more complete analysis of the habitats along the upper Columbia River would be necessary in order to more completely evaluate the manner in which the bird communities are responding to the environment created by activities along the river.

Some general comments can be made about species diversity within the habitat types studied in Table 61. The habitat types can be ranked according to increasing bird species diversity; sand dune, cobble, shrub steppe, riparian shrub, conifer and riparian tree. This ranking also represents increasing habitat complexity. Riparian shrub and riparian tree are also the habitats which are most likely to be influenced by a change in the pattern of water fluctuation.

A preliminary analysis of the census data made it seem inappropriate to lump the data from northern and southern transects of similar habitat type. Moving from the southern to northern ends of the upper Columbia River there is variation in the vegetation along the north-south gradient. Bird communities also show variation as illustrated in Table 63. From north to south there is an increase in the number of species of thrushes, vireos and warblers, and finches and sparrows with a decrease in the numbers of blackbirds. For this reason, the upper Columbia River has been divided into four sections in the analysis of the transect bird data. These sections are identified in Table 62. Also in Table 62 is a listing of the habitats and number of transects censused in each section.

Table 61. Summary of diversity and density (inds/10 ha) for the habitats censused during summer, fall and winter (Number of transects censused is in parentheses). Diversity Index = $-\Sigma$ pi ln pi.

	Summer				Fall				Winter			
	A	B	C	D	A	B	C	D	A	B	C	D
Shrub steppe	(5)	(5)	(7)		(5)	(5)	(5)		(5)	(4)	(5)	
Total species	14.0	11.0	19.0	-	9.0	7.0	8.0	-	5.0	2.0	11.0	-
Average # species/trans.	5.6	4.0	6.7	-	3.8	2.5	1.8	-	1.8	0.4	3.0	-
Average diversity index	1.3	1.2	1.7	-	1.1	0.6	0.4	-	0.3	0.1	0.7	-
Average density	53.0	26.0	29.0	-	32.0	18.0	8.0	-	18.0	16.0	19.0	-
Cobble	(2)	(2)			(2)	(2)			(2)	(2)		
Total species	7.0	6.0	-	-	5.0	3.0	-	-	8.0	0.0	-	-
Average # species/trans.	4.5	3.0	-	-	4.0	1.5	-	-	4.5	0.5	-	-
Average diversity index	0.8	1.0	-	-	1.1	0.5	-	-	1.9	0.0	-	-
Average density	100.0	15.0	-	-	78.0	8.0	-	-	40.0	11.0	-	-
Sand dune	(2)				(2)				(2)			
Total species	6.0	-	-	-	5.0	-	-	-	2.0	-	-	-
Average # species/trans.	3.5	-	-	-	2.5	-	-	-	1.5	-	-	-
Average diversity index	0.7	-	-	-	0.5	-	-	-	0.3	-	-	-
Average density	14.0	-	-	-	23.0	-	-	-	11.0	-	-	-
Riparian shrub	(3)	(5)			(3)	(5)			(5)	(6)		
Total species	17.0	19.0	-	-	13.0	15.0	-	-	15.0	18.0	-	-
Average # species/trans.	8.3	6.4	-	-	7.3	5.6	-	-	7.3	4.8	-	-
Average diversity index	1.7	1.6	-	-	1.2	1.1	-	-	1.0	1.0	-	-
Average density	44.0	75.0	-	-	208.0	83.0	-	-	102.0	62.0	-	-
Riparian tree		(2)		(4)		(2)				(2)		
Total species	-	21.0	-	30.0	-	10.0	-	22.0	-	9.0	-	10.0
Average # species/trans.	-	16.0	-	14.3	-	8.0	-	7.2	-	6.0	-	4.0
Average diversity index	-	2.5	-	2.6	-	1.1	-	1.2	-	1.3	-	0.9
Average density	-	159.0	-	136.0	-	197.0	-	87.0	-	56.0	-	17.0

Table 61. Cont.

	Summer				Fall				Winter			
	A	B	C	D	A	B	C	D	A	B	C	D
Conifer			(5)	(6)			(2)	(6)			(3)	(4)
Total species	-	-	28.0	25.0	-	-	11.0	16.0	-	-	12.0	13.0
Average # species/trans.	-	-	13.0	12.2	-	-	4.3	6.3	-	-	6.0	6.0
Average diversity index	-	-	2.3	2.2	-	-	0.9	1.3	-	-	1.2	1.5
Average density	-	-	165.0	102.0	-	-	15.0	39.0	-	-	129.0	35.0

Section A- Hanford, Priest Rapids, Wanapum
Section B- Rock Island, Rocky Reach, Wells
Section C- Rufus Woods, South FDR
Section D- North FDR

Table 62. Numbers of transects sampled by habitat type in the four river sections identified for bird census data analysis.

Section A.	Hanford			Priest Rapids			Wanapum			Total		
	Su	F	W	Su	F	W	Su	F	W	Su	F	W
Riparian shrub	0	0	2	2	2	2	1	1	1	3	3	5
Equisetum	1	1	1	0	0	0	0	0	0	1	1	1
Grassland	1	1	1	0	0	0	0	0	0	1	1	1
Cobble	2	2	2	0	0	0	0	0	0	2	2	2
Shrub steppe	3	3	3	1	1	1	1	1	1	5	5	5
Sand dune	1	1	1	0	0	0	1	1	1	2	2	2
Total	8	8	10	3	3	3	3	3	3	14	14	16

Section B.	Rock Island			Rocky Reach			Wells			Total		
	Su	F	W	Su	F	W	Su	F	W	Su	F	W
Riparian shrub	1	1	1	1	1	2	3	3	3	5	5	6
Riparian tree	2	2	2	0	0	0	0	0	0	2	2	2
Cobble	0	0	0	1	1	1	1	1	1	2	2	2
Shrub steppe	1	1	1	3	3	2	1	1	1	5	5	4
Total	4	4	4	5	5	5	5	5	5	14	14	14

Section C.	Rufus Woods			South FDR			Total		
	Su	F	W	Su	F	W	Su	F	W
Conifer	2	0	2	3	3	1	5	3	3
Shrub steppe	4	2	4	3	3	1	7	5	5
Total	6	2	6	6	6	2	12	8	8

Section D.	North FDR			Total		
	Su	F	W	Su	F	W
Riparian tree	4	5	3	4	5	3
Conifer	6	6	4	6	6	4
Juniper	1	1	1	1	1	1
Grassland	0	1	1	0	1	1
Total	11	13	9	11	13	9
GRAND TOTAL	51	49	47			

Table 63. Composition of bird communities in each of the four sections of the upper Columbia River, by number of species in the most abundant taxonomic groups.

Section A - Hanford, Priest Rapids, Wanapum
Section B - Rock Island, Rocky Reach, Wells
Section C - Rufus Woods, South FDR
Section D - North FDR

	Summer				Fall				Winter			
	A	B	C	D	A	B	C	D	A	B	C	D
Game birds	2	3	3	2	2	3	3	2	3	2	2	1
Woodpeckers	0	2	2	5	0	2	1	3	1	2	3	1
Flycatchers	2	4	4	3	0	0	0	0	0	0	0	0
Chickadees and Nuthatches	0	0	2	3	0	0	3	4	0	1	2	4
Thrushes	1	1	3	4	1	0	1	2	2	3	2	1
Vireos and Warblers	2	4	4	7	4	3	2	3	1	0	0	0
Blackbirds	6	5	4	4	1	2	1	0	1	0	1	0
Finches and Sparrows	3	3	9	8	4	6	4	8	5	5	7	5

The ranking for the fall and winter season shows one difference. During these seasons, the riparian shrub transects supported the greatest number of different species. Riparian shrub habitat generally occurs in narrow strips and small patches which may be too small to support breeding pairs but in the fall these strips and small patches assume a greater importance to the birds as they move through the countryside in search of suitable places to forage. Observations made while moving from location to location along the river indicate that these small patches of riparian shrub as well as the small groves of trees (too small for the placement of a transect) are even more important to the fall and winter birds than the data collected would indicate.

Summer (presumably breeding birds) included:

Killdeer, Spotted Sandpiper, Western Wood Peewee, Horned Lark, Black-billed Magpie, Orange-crowned Warbler, Yellow Warbler, Red-winged Blackbird, Yellow-headed Blackbird, Brewer's Blackbird, Western Meadowlark, Brown-headed Cowbird, Northern Oriole, Western Tanager, American Goldfinch, Pine Siskin, Western Kingbird, Robin, Loggerhead Shrike, Yellowthroat, House Sparrow, Calliope Hummingbird, Red-shafted Flicker, Downy Woodpecker, Empidonax Flycatcher (sp.), Cedar Waxwing, Starling, Solitary Vireo, Wilson's Warbler, Lewis' Woodpecker, Yellow-bellied Sapsucker, Dusky Flycatcher, Black-capped Chickadee, Veery, Swainson's Thrush, Red-eyed Vireo, Warbling Vireo, Yellow-rumped Warbler, American Redstart, Nashville Warbler, Rufous-sided Towhee, Lazuli Bunting, Song Sparrow, Chipping Sparrow, Junco, Say's Phoebe, House Finch, Pygmy Nuthatch, House Wren, Sage Thrasher, Townsend's Solitaire, Purple Finch, Cassin's Finch, Lark Sparrow, Clark's Nutcracker, Mountain Chickadee, White-breasted Nuthatch, Hairy Woodpecker, Red Crossbill, Water Pipit, Rock Wren, Canyon Wren, and Crow.

Small Mammals

Bats of seven species were collected: big brown, little brown, western pipistrelli, hairy-winged, silver-haired, Yuma myotis, and western big-eared. Some crude estimates of occurrence and numbers were made. It seems probable that increases in riparian tree growth, particularly broadleafed trees, would favor bat populations by providing loose bark for shelter and increased insect populations. We found mist nets ineffective for bat collection, and discontinued their use after 74 net nights and one collected bat -- a Yuma myotis (*Myotis yumanensis*). Bats were able to detect and avoid the nets. Thirty-six bats of seven species were collected (Table 64) by shotgun, of which 25 (69%) were big brown bats (*Eptesicus fuscus*) (Table 64). The number of flying bats observed per transect was 20.7 over riparian shrub, 6.8 over riparian tree, 13.4 over conifer, and 26.5 over shrub

Table 64. Number of bats (B) observed and collected per transect (T) examined for 45 minutes at dusk along the upper Columbia River, 30 July - 9 September 1974.

Segment	Habitat														
	Grassland			Cobble			Shrub steppe			Sand dune			Total		
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans	B/T	No. bats	No. trans.	b/T
Hanford															
Observed	0	1	0.0	0	1	0.0	2	2	1.0	0	1	0.0	2	5	0.4
	Riparian shrub														
	No. bats	No. trans.	B/T												
Priest Rapids															
Observed	11	2	5.5												
	Riparian shrub			Shrub steppe			Total								
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T						
Wanapum															
Observed	72	1	72.0	24	1	24.0	96	2	48.0						
Collected															
Western pipistrelle *(Pipistrellus hesperus)*	0	-	-	1	-	-	1	-	-						
Big brown bat *(Eptesicus fuscus)*	4	-	-	-	-	-	4	-	-						
	Riparian shrub			Riparian tree			Shrub steppe			Total					
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T			
Rock Island															
Observed	0	1	0.0	10	1	10.0	57	1	57.0	67	3	22.3			

Table 64. Cont.

Segment	Habitat											
	Riparian shrub			Cobble			Shrub steppe			Total		
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T
Rocky Reach												
Observed	10	1	10.0	3	1	3.0	59	2	29.5	72	4	18.0
Collected												
Big brown bat (*Eptesicus fuscus*)	1	-	-	0	-	-	1	-	-	2	-	-
	Riparian shrub			Shoreline gravel			Shrub steppe			Total		
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T
Wells												
Observed	52	2	26.0	18	1	18.0	87	1	87.0	157	4	39.3
Collected												
Big brown bat (*Eptesicus fuscus*)	0	-	-	1	-	-	2	-	-	3	-	-
Little brown myotis (*Myotis lucifugus*)	0	-	-	0	-	-	2	-	-	2	-	-
	Conifer[a]			Shrub steppe			Total[a]					
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T			
Rufus Woods												
Observed	26	1	26.0	71	3	23.7	97	4	24.3			
Collected												
Big brown bat (*Eptesicus fuscus*)	0	-	-	2	-	-	2	-	-			
Western pipistrelle (*Pipistrellus hesperus*)	0	-	-	1	-	-	1	-	-			

Table 64. Cont.

Segment	Habitat								
	Conifer			Shrub steppe[b]			Total[b]		
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T
South F.D.R.									
Observed	41	2	20.5	50	2	25.0	91	4	22.8
Collected									
Big brown bat (*Eptesicus fuscus*)	0	-	-	7	-	-	7	-	-
Little brown myotis (*Myotis lucifugus*)	0	-	-	1	-	-	1	-	-
	Riparian tree			Conifer[c]			Total[c]		
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T
North F.D.R.									
Observed	2	1	2.0	40	4	10.0	42	5	8.4
Collected									
Big brown bat (*Eptesicus fuscus*)				8	-	-	8	-	-
Hairy-winged bat (*Myotis volans*)				1	-	-	1	-	-
Silver-haired bat (*Lasionycteris noctivagans*)				1	-	-	1	-	-
	Riparian tree[c]			Conifer			Total		
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T
B.C.									
Observed	29	4	7.3	3	1	3.0	32	5	6.4
Collected									
Big brown bat (*Eptesicus fuscus*)	1	-	-	0	-	-	1	-	-
Yuma myotis (*Myotis yumanensis*)	1	-	-	0	-	-	1	-	-
Western big-eared bat (*Corynorhinus townsendii*)	2	-	-	0	-	-	2	-	-

Table 64. Cont.

Segment	Habitat											
	Riparian shrub			Riparian tree			Grassland			Cobble		
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T
Total												
Observed	145	7	20.7	41	6	6.8	0	1	0.0	3	2	1.5
Collected												
Big brown bat *(Eptesicus fuscus)*	5	-	-	1	-	-	0	-	-	6	-	-
Little brown myotis *(Myotis lucifigus)*	0	-	-	0	-	-	0	-	-	0	-	-
Yuma myotis *(Myotis yumanensis)*	0	-	-	1	-	-	0	-	-	0	-	-
Hairy-winged myotis *(Myotis volans)*	0	-	-	0	-	-	0	-	-	0	-	-
Silver-haired bat *(Lasionycteris noctivagans)*	0	-	-	0	-	-	0	-	-	0	-	-
Western pipistrelle *(Pipistrellus hesperus)*	0	-	-	0	-	-	0	-	-	0	-	-
Western big-eared bat *(Corynorhinus townsendii)*	0	-	-	2	-	-	0	-	-	0	-	-

Table 64. Cont.

Segment	Habitat														
	Shoreline gravel			Conifer			Shrub steppe			Sand dune			Total		
	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T	No. bats	No. trans.	B/T
Total (Continued)															
Observed	18	1	18.0	107	8	13.4	318	12	26.5	0	1	0.0	632	38	16.6
Collected															
Big brown bat (*Eptesicus fuscus*)	1	-	-	7	-	-	11	-	-	0	-	-	25	-	-
Little brown myotis (*Myotis lucifigus*)	0	-	-	0	-	-	4	-	-	0	-	-	4	-	-
Yuma myotis (*Myotis yumanensis*)	0	-	-	0	-	-	0	-	-	0	-	-	1	-	-
Hairy-winged myotis (*Myotis volans*)	0	-	-	1	-	-	0	-	-	0	-	-	1	-	-
Silver-haired bat (*Lasionycteris noctivagans*)	0	-	-	1	-	-	0	-	-	0	-	-	1	-	-
Western pipistrelle (*Pipistrellus hesperus*)	0	-	-	0	-	-	2	-	-	0	-	-	2	-	-
Western big-eared bat (*Corynorhinus townsendii*)	0	-	-	0	-	-	0	-	-	0	-	-	2	-	-

[a]One other conifer transect (T47) was sampled during early morning when three bats were counted.

[b]One other shrub steppe transect (T55) was sampled using car headlights, and 19 bats were counted.

[c]Two conifer transects (T57 and T62) and one birch transect (T60) were sampled after dusk, and 0 and 2 bats, respectively, were counted.

steppe. Transects located near cliff areas seemed to be the most productive. Since riparian vegetation may be more productive for insects than other habitats are, those riparian areas near cliff areas might be expected to be most productive for bats foraging for flying insects. However, data collected suggest shrub steppe near cliffs and water might be at least as important as riparian areas for bats.

Small mammals, like small birds, are more closely tied to specific plant communities than are larger forms. However, during the period of dispersal of young, in late summer and fall, they are also found in many other places.

By trapping our transects seasonally, we found 9 species of small mammals in addition to those mentioned earlier. These 9 were: Deer mouse, Pocket mouse, Harvest mouse, House mouse, Grasshopper mouse, Montane, Long-tailed and Meadow voles and Vagrant shrew. In addition, the track of Ord's kangaroo rat was found on Hanford and Priest Rapids segments, north of the range hitherto reported. The Sagebrush vole has been reported from Hanford, but was not found by us. During the spring we trapped a group usually of four transects two nights in succession before moving on to the next group of transects. In the fall we trapped three nights in succession to determine if an extra night resulted in the collection of additional species. Rarely, on an individual transect, the third night resulted in an additional species. When transects were combined by habitat and/or segment, the third night resulted in no additional species, but the second night did (Table 65). Thus, two nights of trapping seem to provide as good a sampling of species as three nights. Generally, as animals were trapped and removed from the transects, the number of animals trapped per 100 trap nights decreased as expected.

The relative density of small mammals as a group was about twice as high in the fall as in the spring, as expected, but the number of species present was about the same (Table 66).

Tables 67 and 68 indicate the selectivity of specific trap types for specific species. For instance, the baited museum special and Sherman live trap seemed to be most effective for most mice, while pit traps do best for shrews. In calculating catch per 100 trap-nights we used only data from types of traps which were successful in taking the species in question. These data are summarized in Table 69.

We recorded 13 species of small mammals on the transects (Table 69). Twenty and 9 percent of the transects trapped in spring and fall, respectively, yielded no small mammals whatever. Deer mice were most abundant, at 5.2 and 8.4 per 100 trap nights in spring and fall, respectively. In the shrub steppe, Great Basin pocket

Table 65. Comparison of 1st, 2nd, and 3rd nights of trapping small mammals, with percent frequency of occurrence (occupied transects/total transects) by habitat, fall 1974. (Number of transects in parentheses.)[e]

Species	Accumulative on occupied transects only: No. trapped 1st	2nd	3rd	No. trap nights[a] 1st	2nd	3rd	No. animals per 100 trap nights 1st	2nd	3rd	Percent occurrence
Riparian shrub (10)										
Unsuccessful transect(s)	0	0	0	30	60	90	0.0	0.0	0.0	10
Deer mouse *(Peromyscus maniculatus)*	37	58	83	274	548	822	13.5	10.6	10.0	70
Montane vole *(Microtus montanus)*	4	8	10	122	244	366	3.3	3.3	2.7	30
House mouse *(Mus musculus)*	3	4	5	130	260	390	2.3	1.5	1.3	30
Vagrant shrew *(Sorex vagrans)*	1	3	5	45	90	135	2.2	3.3	3.7	10
Western harvest mouse *(Reithrodontomys megalotis)*	3	5	6	130	260	390	2.3	1.9	1.5	30
Long-tailed vole *(Microtus longicaudus)*	0	0	3	45	90	135	0.0	0.0	2.2	10
Total[b]	48	78	112	364	728	1092	13.2	10.7	10.3	90
Riparian tree (7)										
Deer mouse *(Peromyscus maniculatus)*	19	32[c]	43	252	504[c]	711	7.5	6.3	6.0	86
Montane vole *(Microtus montanus)*	1	2[c]	4	45	90[c]	135	2.2	2.2	3.0	14
Vagrant shrew *(Sorex vagrans)*	2	6	6	162	324	486	1.2	1.9	1.2	57
Yellow-pine chipmunk *(Eutamias amoenus)*	1	2	3	90	180	270	1.1	1.1	1.1	29
Western harvest mouse *(Reithrodontomys megalotis)*	2	3	3	81	126	171	2.5	2.4	1.8	29
Long-tailed vole *(Microtus longicaudus)*	2	0	2	36	36	36	5.6	0.0	5.6	14
Total[b]	27	45[c]	61	288	540	747	9.4	8.3	8.2	100
Grassland (2)										
Deer mouse *(Peromyscus maniculatus)*	2	6	4[c]	95	170	120[c]	2.1	3.5	3.3	100
Meadow vole *(Microtus pennsylvanicus)*	0	1	-	45	90	-	0.0	1.1	-	50
Total[b]	2	7	4[c]	85	170	120[c]	2.4	4.1	3.3	100
Cobble (3)										
Unsuccessful transect(s)	0	0	0	80	160	240	0.0	0.0	0.0	67
Deer mouse *(Peromyscus maniculatus)*	5	5	6	36	72	108	13.9	6.9	5.6	33
Total[b]	5	5	6	116	232	348	4	2	2	33
Shoreline gravel (1)										
Deer mouse *(Peromyscus maniculatus)*	1	2	2	30	60	90	3.3	3.3	2.2	100

Table 65. Cont.

Species	Accumulative on occupied transects only: No. trapped 1st	2nd	3rd	No. trap nights[a] 1st	2nd	3rd	No. animals per 100 trap nights 1st	2nd	3rd	Percent occurrence
Conifer (9)										
Deer mouse *(Peromyscus maniculatus)*	24	39	53	399	798	1197	6.0	4.9	4.4	100
Great Basin pocket mouse *(Perognathus parvus)*	2	4	7	129	258	387	1.6	1.6	1.8	33
Yellow-pine chipmunk *(Eutamius amoenus)*	0	15	29	264	528	792	0.0	2.8	3.7	67
Western harvest mouse *(Reithrodontomys megalotis)*	1	4	7	129	258	387	0.8	1.6	1.8	33
Long-tailed vole *(Microtus longicaudus)*	0	1	1	45	90	135	0.0	1.1	0.7	11
Total[b]	27	63	97	399	798	1197	6.8	7.9	8.1	100
Juniper (1)										
Deer mouse *(Peromyscus maniculatus)*	7	10	11	45	90	135	15.6	11.1	8.1	100
Shrub steppe (16)										
Unsuccessful transect(s)	0	0	0	40	80	120	0.0	0.0	0.0	6
Deer mouse *(Peromyscus maniculatus)*	63	103	121	482	964	1445	13.1	10.7	8.4	69
House mouse *(Mus musculus)*	4	10	11	80	160	240	5.0	6.3	4.6	13
Great Basin pocket mouse *(Perognathus parvus)*	13	24	33	512	1024	1535	2.5	2.3	2.1	75
Northern pocket gopher *(Thomomys talpoides)*	0	2	2	91	182	272	0.0	1.1	0.7	13
Western harvest mouse *(Reithrodontomys megalotis)*	3	4	4	135	270	405	2.2	1.5	1.0	19
Long-tailed vole *(Microtus longicaudus)*	1	2	3	91	182	272	1.1	1.1	1.1	13
Total[b]	84	145	174	602	1204	1806	14.0	12.0	9.6	94
Sand dune (2)										
Deer mouse *(Peromyscus maniculatus)*	9	16	18	80	160	240	11.3	10.0	7.5	100
Great Basin pocket mouse *(Perognathus parvus)*	1	3	4	80	160	240	1.3	1.9	1.7	100
Northern grasshopper mouse *(Onychomys leucogaster)*	0	1	2	40	80	120	0.0	1.3	1.7	50
Total[b]	10	20	24	80	160	240	12.5	12.5	10.0	100

Table 65. Cont.

Species	Accumulative on occupied transects only: No. trapped 1st	2nd	3rd	No. trap nights[a] 1st	2nd	3rd	No. animals per 100 trap nights 1st	2nd	3rd	Percent occurrence
Total (50)[d]										
Unsuccessful transect(s)	0	0	0	150	300	450	0	0	0	8
Deer mouse *(Peromyscus maniculatus)*	167	271	341	1693	2656	5000	10.2	10.2	6.8	78
Montane vole *(Microtus montanus)*	5	10	14	167	334	501	3	3	3	8
Meadow vole *(Microtus pennsylvanicus)*	0	1	0	45	90	135[c]	0	1	1	2
Long-tailed vole *(Microtus longicaudus)*	3	3	9	217	398	578	1.4	0.8	1.6	10
House mouse *(Mus musculus)*	7	14	16	210	420	630	3.3	3.3	2.5	10
Vagrant shrew *(Sorex vagrans)*	3	9	11	207	414	621	1.4	2.2	1.8	10
Yellow-pine chipmunk *(Eutamius amoenus)*	1	17	32	354	708	1062	0	2	3	16
Great Basin pocket mouse *(Perognathus parvus)*	16	31	44	721	1442	2162	2.2	2.1	2	33
Northern pocket gopher *(Thomomys talpoides)*	0	2	2	91	182	272	0	1	0.7	4
Northern grasshopper mouse *(Onychomys leucogaster)*	0	1	2	40	80	120	0	1	2	2
Western harvest mouse *(Reithrodontomys megalotis)*	9	16	20	475	914	1353	1.9	1.8	1.5	22
Total[b] (50)[d]	211	375	491	2009	5991	11,766	10.5	6.3	4.2	92

[a]The number of trap nights involves all traps used.

[b]The total number of trap nights involves the total per transect rather than the total per species on each transect.

[c]A few transects were not trapped the 2nd or 3rd day, and were omitted from calculation on the days not trapped.

[d]One sand dune transect is repeated with the shrub steppe transects, but not with the total.

[e]Scientific nomenclature for all small mammal tables from: Hall, E. R. and K. R. Kelson. 1959. The Mammals of North America, Ronald Press Co. 1083 pp; and Ingles, L. G. 1947. Mammals of the Pacific States, Stanford Univ. Press, 506 pp.

Table 66. Relative species abundance for small mammals trapped using six trap types[a] in different habitats for 2 nights during spring (S), 17 May-28 June, and fall (F), 19 September-10 December 1974.

Habitat	No. transects sampled		No. species trapped		No. animals trapped		No. trap nights		No. species per 100 trap nights		No. animals per 100 trap nights	
	S	F	S	F	S	F	S	F	S	F	S	F
Riparian shrub	8	10	6	6	49	78	760	788	0.8	0.5	6.6	9.9
Equisetum	1	0	3	0	3	0	72	0	4.2	-	4.2	-
Riparian tree	6	7	2	6	24	45	467	504	0.4	0.8	5.1	8.9
Grassland	1	2	1	2	3	7	92	170	1.1	1.2	3.3	4.1
Cobble	3	3	1	1	1	5	272	232	0.4	0.4	0.4	2.2
Shoreline gravel	1	1	0	1	0	2	90	60	0.0	1.7	0.0	3.3
Conifer	11	9	2	6	34	63	882	798	0.2	0.8	3.9	8.1
Juniper	1	1	1	1	8	10	90	90	1.1	1.1	8.9	8.1
Shrub steppe	18	16	7	7	91	134	1639	1284	0.4	0.5	5.6	10.4
Sand dune	2	2	2	3	8	20	264	160	0.8	1.9	3.0	10.0
Total	52	50	8	11	222	364	4628	4086	0.2	0.3	4.8	8.9

[a]Baited and unbaited museum specials, sherman live, rat, pit traps, and Conibear 110.