WlLDLIFE AND WlLDLlFE HABITAT LOSS ASSESSMENT AT HILLS CKEEK DAM AND RESERVOIR PROJECT MIDDLE FOKK WILLAMETTE RIVER, OREGON

FINAL REPORT

BY

J. H. Noyes
M. S. Potter
K. L. Bedrossian
Vegetation Analysis by J. 8. Glad

Oregon Department of Fish and Wildlife
Environmental Management Section

Prepared For

Jim Meyer, Project Manager

U.S. Department of Energy

Bonneville Power Administration

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ABSTRACT

A habitat based assessment was conducted of the U.S. Army Corps of Engineers' Hills Creek Dam and Reservoir Project on the Middle Fork Willamette River, Oregon, to determine losses or gains resulting from the development and operation of the hydroelectric related components of the project. Preconstruction, postconstruction, and recent vegetation cover types of the project site were mapped based on aerial photographs from 1944, 1964, and 1979, respectively. Vegetation cover types were identified within the affected area and acreages of each type at each period were determined. Fifteen wildlife target species were selected to represent a cross-section of species groups affected by the project. An interagency team evaluated the suitability of the habitat to support the target species at each time period. An evaluation procedure which accounted for both the quantity and quality of habitat was used to aid in assessing impacts resulting from the project. The Hills Creek Project extensively altered or affected 4,662 acres of land and river in the Middle Fork Willamette River drainage. Impacts to wildlife centered around the loss of 2,694 acres of old-growth forest and 207 acres of riparian habitat. Impacts resulting from the Hills Creek Project included the loss of winter range for Roosevelt elk, and the loss of year-round habitat for black-tailed deer, black bear, cougar, river otter, beaver, ruffed grouse, spotted owl, and other nongame species. bald eagle and osprey were benefitted by an increase in foraging habitat. The potential of the affected area to support wildlife was greatly altered as a result of the Hills Creek Project, losses or gains in the potential of the habitat to support wildlife will exist over the life of the project.

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I. INTRODUCTION

This loss statement addresses the impacts to wildlife resources resulting from the development and operation of the hydroelectric-related components (e.g., dam, reservoir) of U.S. Army Corps of Engineers' (USACE) Hills Creek Project. The study was funded by Bonneville Power Administration and was designed to meet requirements of Measure 1004(b)(2) of the Columbia River Basin Fish and Wildlife Program adopted by the Northwest Power Planning Council pursuant to Section 4(h) of the Northwest Electric Power Planning and Conservation Act of 1980.

The objectives of the study were to: 1) provide for consultation and coordination with interested parties, 2) identify probable effects of past development and operation of the Hills Creek Project to wildlife and wildlife habitat, and 3) determine the hydroelectric portion of the wildlife resource losses at the Hills Creek Project. A habitat based approach was used to identify effects of the project and to determine losses or gains in the potential of the project area to support wildlife.

II. STUDY AREA

A. Project Description

Hills Creek Dam and Reservoir are located at river mile 47.8 of the Middle Fork Willamette River in Lane County, Oregon. The project is 5 miles southeast of Eugene within the boundary of the Willamette National Forest (USACE 1982). The Hills Creek Project is within the Oregon Department of Fish and Wildlife (ODFW) Indigo Wildlife Management Unit, and the Rigdon Ranger District of the Willamette National Forest.

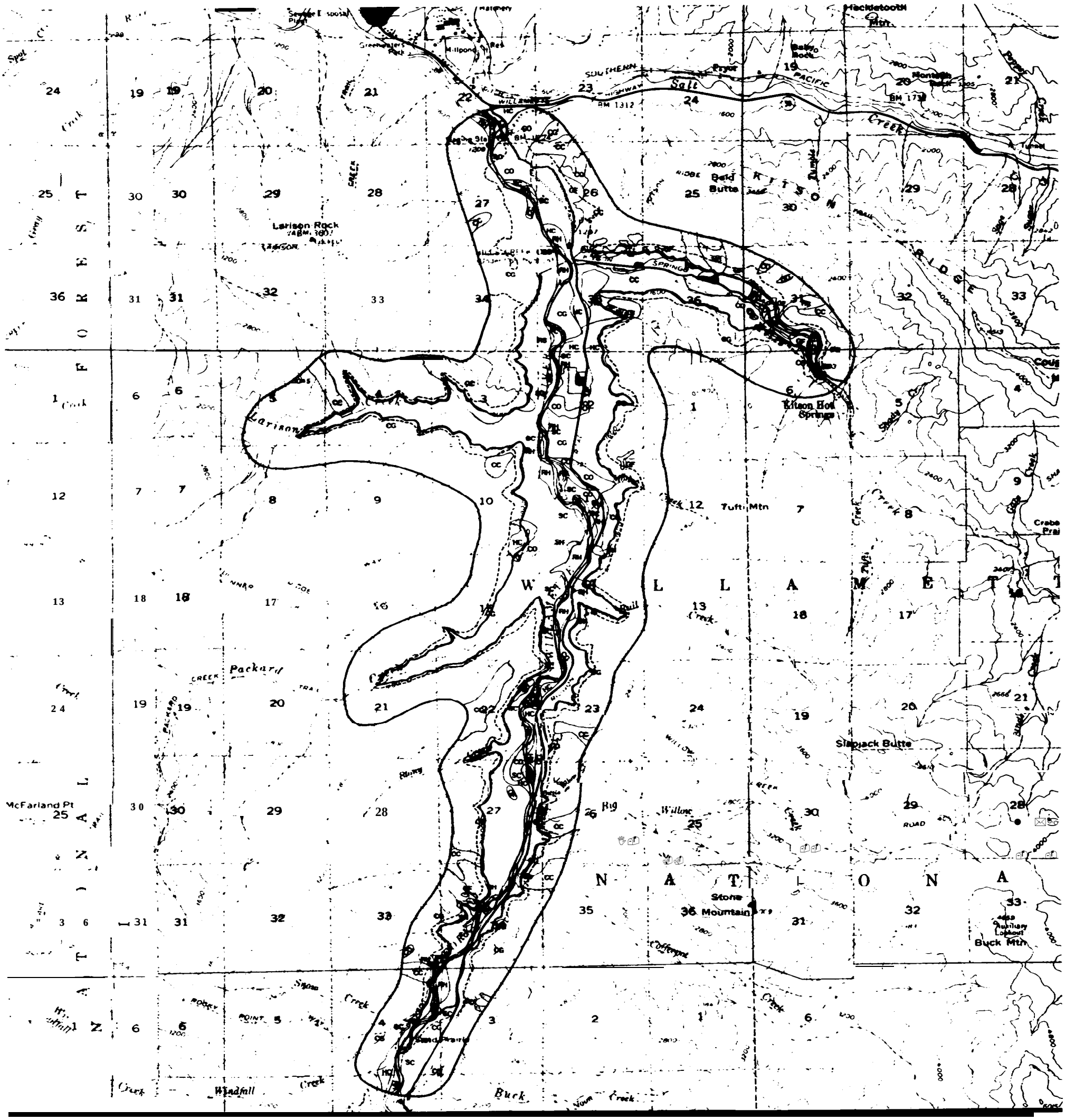
The project structure is an earth-and-gravel-fill.dam 2,150 feet long at the crest and 338 feet high. Power is generated by two 15,000 kilowatt turbines (USACE 1982). The surface area of Hills Creek Reservoir is 2,710 acres at full pool level. The reservoir is 8.5 miles long and has a maximum width of 0.75 miles (USACE 1982, U.S. Forest Service [USFS] 1983). Maximum pool elevation is 1,543 feet and minimum power pool elevation is 1,414 feet (USACE 1980).

Hills Creek Dam and Reservoir Project was authorized by the Flood Control Act of 1950. Construction began in 1956. In 1963 flood control commenced and in 1962 the 2 power generators were operating. The Hills Creek Project was considered complete as of June 1963 except for miscellaneous improvements (USACE 1963).

B. Study Area Description

The "affected area" referred to in this report was most intensively studied and included that area directly affected by project construction and operation. The affected area encompassed the reservoir, project facilities, staging areas, and relocated roads (Figures 1-3). Areas not directly affected by the project, but within the range of species using the project area, were considered when determining qualitative impacts.

Figure 1



Vegetation cover types of the Hills Creek Reservoir area - preconstruction, 1944.

CO Temperate conifer forest, open	m Riparian shrub
a Temperate conifer forest, closed	RH - -
CG Temperate conifer forest, old growth	SC Sand / gravel / cobble
HC Conifer-hardwood forest	DB Disturbed / bare / rock
HD Deciduous hardwoods (oak)	Residential
RA Red alder	0 Agricultural, cropland
SH Shrubland	Agricultural, pasture
GF Grass-forb	River
CF Coniferous wetland	

---- **Affected Area**

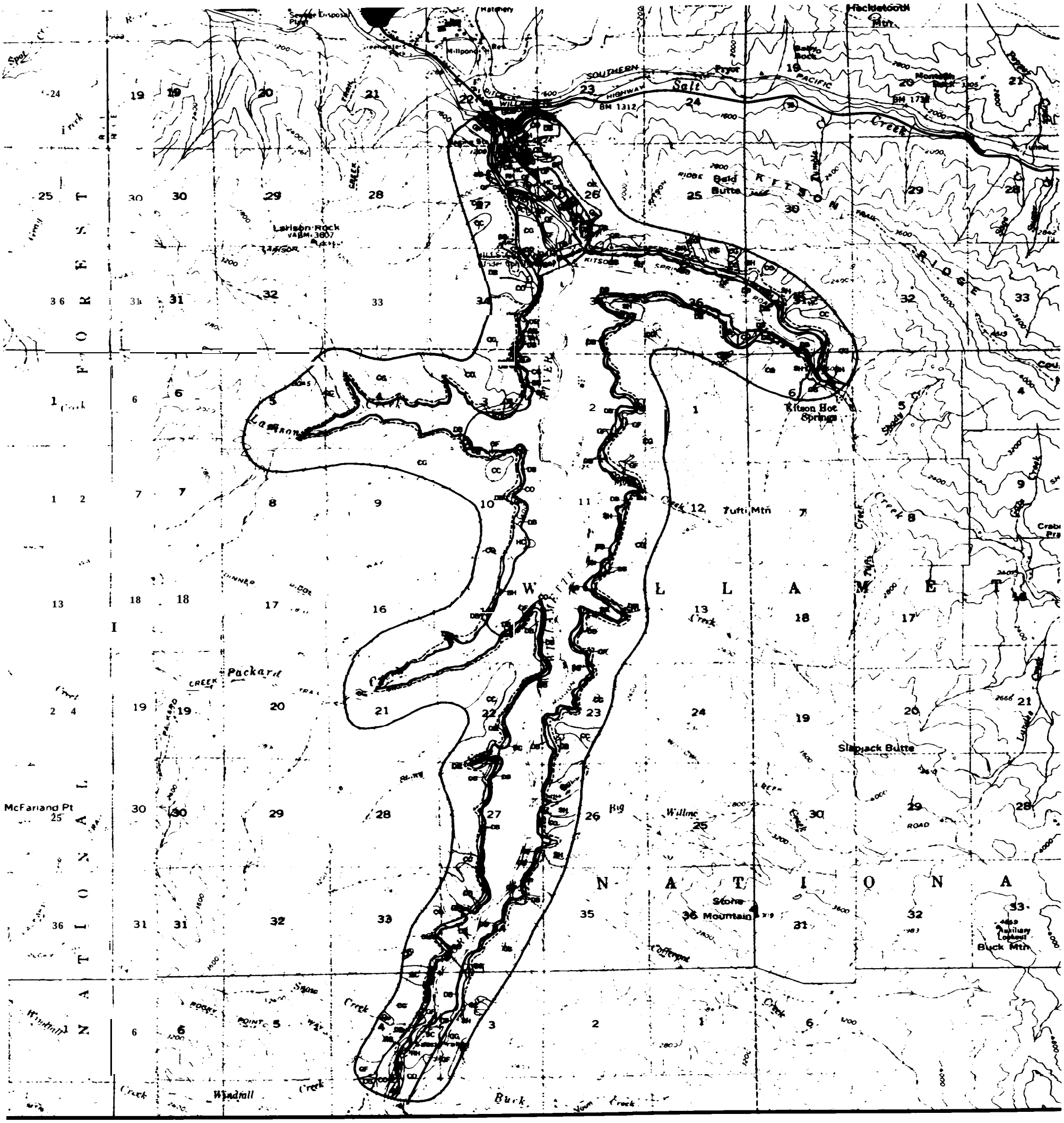
N

4 MILES

21000 FEET

5 KILOMETRES

Figure 2



Vegetation cover types of the Hills Creek Reservoir area - postconstruction, 1964.

CO	Temperate conifer forest, open	RS	Riparian shrub
CC	Temperate conifer forest, closed	RH	Riparian hardwoods
CG	Temperate conifer forest, old growth	SC	Sand / gravel / cobble
HC	Conifer-hardwood forest	DB	Disturbed / bare / rock
HD	Deciduous hardwoods (oak)		
RA	Red alder		Agricultural, cropland
SH	Shrubland		
GF	Grass-forb		
CF	Coniferous wetland		

---- Affected Area

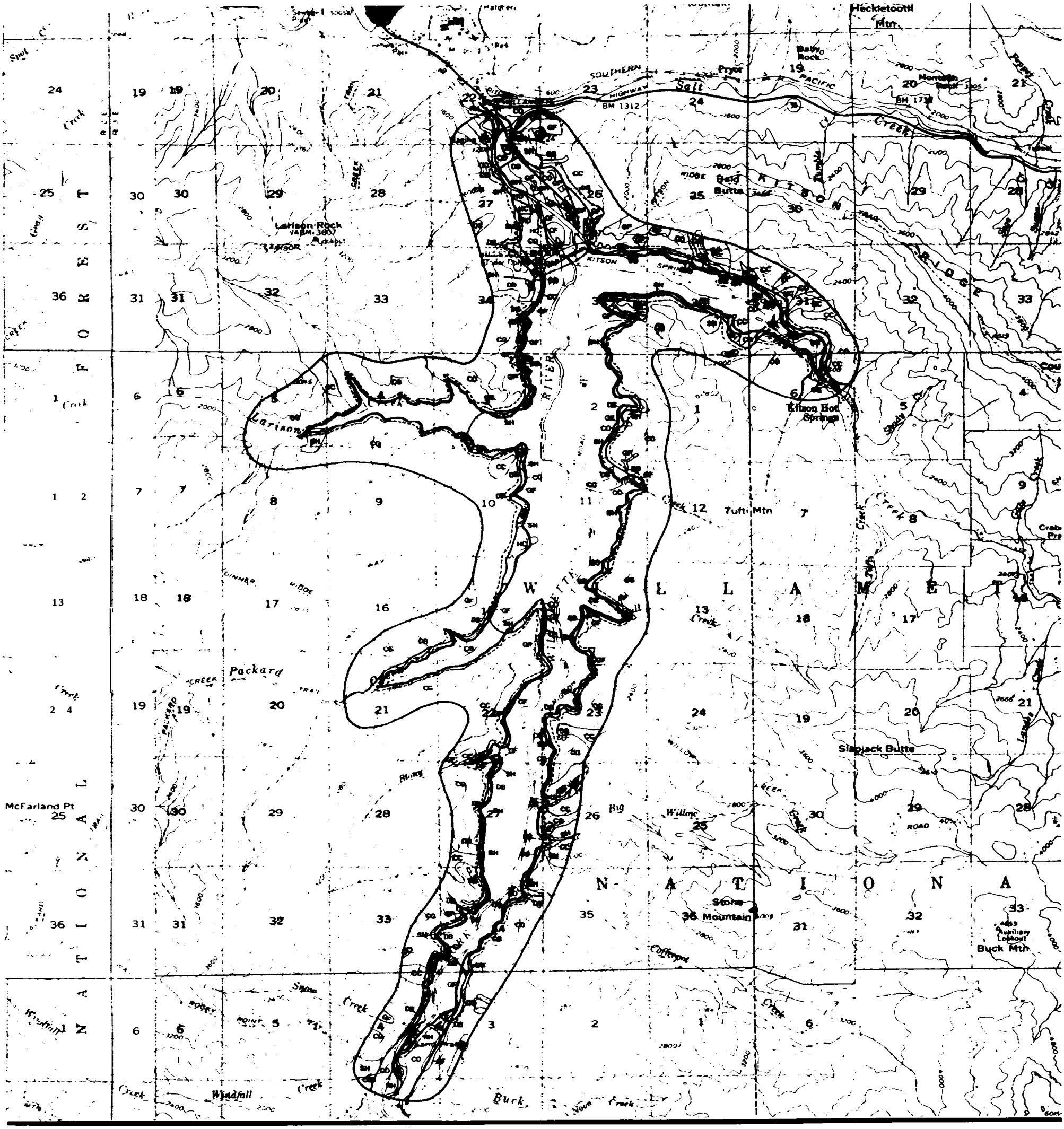
N

0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 5 0 1 2 3 4 5 KILOMETRES

Figure 3



Vegetation cover types of the Hills Creek Reservoir area - recent, 1979.

W	Temperate conifer forest, open
CC	Temperate conifer forest, closed
W	Temperate conifer forest, old growth
HC	- - -
HD	Deciduous hardwoods (oak)
RA	Red alder
SH	Shrubland
GF	Grass-forb
CF	- -
RS	Riparian shrub
RH	Riparian hardwoods
SC	Sand / gravel / cobble
DB	Disturbed / bare / rock
■	
□	Agricultural, cropland

- - - - Affected Area

N

4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 5 0 1 2 3 4 5 KILOMETRES

The Hills Creek Project is located in the Western Hemlock Zone described by Franklin and Dyrness (1973). The Middle Fork Basin was "rugged and largely covered with a heavy stand of timber" (USACE and USFS 1963). The reservoir site was characterized by stands of Douglas-fir, western red cedar, and western hemlock. Scattered stands of bigleaf maple and cottonwood occurred on the lower slopes. Common understory vegetation included willows, vine maple, red alder, Pacific dogwood, rhododendron, salal, fern, blackberry, and various grasses and forbs (U.S. Fish and Wildlife Service [USFWS] 1958). USFWS (1958) identified project land as: 1,250 acres of Federal land, most of which were forested; and 1,586 acres of private land of which approximately 1,300 acres were forested, 26 acres were cultivated, and 260 acres were untillable. Seven summer homesites or rental units, 3 small farms, and a logging campsite were located within the impoundment site (USFWS 1958). More detailed descriptions of vegetation cover types and acreages are provided in Section IV.A.l. of this report.

Black-tailed deer, Roosevelt elk, and black bear inhabited the project site prior to project construction. Cougar, bobcat, beaver, river otter, mink, raccoon, brush rabbit, and skunk inhabited the reservoir area, as did blue grouse, ruffed grouse, mountain quail, mourning dove, and band-tailed pigeon (USFWS 1958; USACE and USFS 1968; R. Jubber, ODFW, pers. commun.). Preconstruction information on nongame species was not documented. In addition to those species documented to be present prior to construction, the affected area potentially supported many more wildlife species (Appendix A).

C. Land Ownership

USACE is responsible for 204 acres of land adjacent to the reservoir which are necessary for operational purposes. USFS manages activities on the 2,710-acre water surface of the reservoir and administers land contiguous to the reservoir within the National Forest boundary (L. Klenke, USACE, pers. commun.).

III. MEHTODS

A. Consultation and Coordination

A list of agencies and their representatives interested in participating in the consultation/coordination process was developed and updated throughout the study. Parties on this list received correspondence informing them of the project effort and of consultation/coordination meetings. Participating agencies and individuals were contacted by phone or in person repeatedly throughout the study. Meeting minutes, draft species lists, target species lists, vegetation cover type descriptions, acreage tables, habitat rating system descriptions, and sections of the draft report were provided to those agencies and individuals expressing interest in the loss statement. Study procedures, the species list, target species, vegetation mapping, and report drafts were discussed at meetings and comments were requested and documented. Interested agencies were represented by participants in the habitat rating process (see Section III.E.).

B. Vegetation Cover Type Mapping

Preconstruction, postconstruction, and recent vegetation cover types of the Hills Creek Reservoir area were mapped based on aerial photographs from 1944, 1964, and 1979 obtained from USACE in Portland and the University of Oregon Map Library. All photographs were black and white and scales varied from 1:13,200 to 1:30,000. The base map was derived from 1:62,500 USGS quadrangle maps, enlarged to 1:24,000 and screened on mylar film. The area mapped extended 1/4 mile from the full pool reservoir shoreline. Vegetation cover types were based on categories described by Hall et al. (1985) and are described in section IV.A.l.

The aerial photographs were overlaid with mylar film and examined under a stereoscope. Areas of discernibly similar vegetation cover were outlined (polygons) and labeled with a symbol designating cover type. These designations were checked against timber type maps obtained from the Willamette National Forest and photographs taken during site visits. The polygons on the overlays were then transferred to the base map using known landmarks, slope, ridge and valley topography, and proportional dividers to locate each polygon accurately.

The recent map was ground truthed on 17 December 1984. Cover type categories designated on the map were visually verified and if necessary, changes were made to the draft recent map, then to post-construction and preconstruction maps. All maps were then finalized and traced onto mylar overlays to the base map. A boundary including only the area directly affected by the project was determined from analysis of the aerial photographs and vegetation maps and was drawn on the base map. Acreages of map categories within the affected area boundary were calculated from blackline reproductions of the three maps, using the known area of the reservoir as a basis for assigning acreages to polygons. The affected area was narrow and contained many small polygons, therefore, a dot grid was used to calculate acreages. Dot counts among the three maps agreed within l%, and counts of the reservoir surface only differed by 2%, indicating good accuracy had been obtained.

C. Literature Review and Interviews

ODFW, USFWS, and USFS files were examined for wildlife/habitat information relevant to the Hills Creek Project area. An extensive review of journal articles was conducted to locate research findings pertinent to the project area. Much of the available information on the status of wildlife populations during the preconstruction and postconstruction periods was identified in the status report on wildlife mitigation at Hills Creek Reservoir (Bedrossian et al. 1984). Interviews were conducted with ODFW, USFWS, and USFS biologists, and other individuals knowledgeable of wildlife/habitat conditions in the project area.

D. Target Species

Wildlife species potentially occurring in the project area (Appendix A) were identified based on a list of wildlife in the Willamette National Forest (USFS undated) and the Oregon nongame wildlife management plan review draft (Marshall 1984). From these lists, target species were

selected based on factors such as threatened or endangered status, priority according to State or Federal programs, recreational or economic importance, or degree of impacts resulting from the project. Target species selected represent a cross-section of species groups (species that have similar habitat requirements) affected by the project and were used to evaluate the losses or gains in the potential of the project area to support wildlife.

E. Impact Analysis

The method used to aid in evaluating the loss or gain of wildlife habitat as a result of the Hills Creek Project was based on the "Habitat evaluation procedure" developed by USFWS (1976, 1980), "Ecological planning and evaluation procedures" developed by the Joint Federal-State-Private Conservation Organization Committee (1974), and discussions with various USFWS, USACE, and ODFW personnel.

For each target species, the acres of cover types potentially used within the affected area were totaled to determine the acres of habitat available to each target species at preconstruction, postconstruction, and recent time periods. Tables summarizing the cover types and acreages available to each target species were prepared. Habitat rating criteria worksheets providing information on habitat requirements were prepared for each target species and are available from ODFW. The worksheets provided a standard from which ratings were based.

Participating agencies designated individuals having expertise on the project area and/or target species to attend the habitat rating meeting (Appendix B). Each person was provided with habitat rating criteria worksheets, drafts of background information sections of the loss statement report, and tables of cover type acreages. Cover type maps and aerial photos were available and were consulted frequently during the rating session. The habitat rating group spent one day touring the project area, looking at habitat that was similar to that altered by the project, and discussing preconstruction, postconstruction, and present habitat conditions as well as target species. At the rating session, acres of habitat available for each target species were agreed upon based on cover types, location, and other factors (e.g., forest stand condition), which might indicate whether an area was used as habitat. Once the available habitat was identified, the quality of the habitat at preconstruction, postconstruction, and recent time periods was rated on a scale of 1 to 10 (1=low quality habitat, 5=average quality habitat, 10=optimum habitat) for each target species. Ratings were derived from the site visit, aerial photographs, vegetation maps, habitat requirements of the target species, and the biologists' expertise. Reasons for assigning each suitability rating were documented and are discussed in this report. Factors other than hydroelectric development and operation that may have influenced the value of the habitats were considered but did not affect the assigned ratings unless otherwise noted in the text of this report.

The ratings for each target species at each time period were then divided by the optimum habitat value (10) to provide a habitat suitability index. The habitat suitability index was then multiplied by the

number of acres of habitat available to that species at that time period to determine habitat units (HU's) available. HU's provide a relative index of the importance of the habitat to that particular species. One species. One HU is equal to one acre of optimum quality or prime habitat for that species.

HU's available to each target species prior to project construction were subtracted from postconstruction HU's to determine the loss or gain of the potential of the habitat to meet the requirements of each target species as a result of project construction. Preconstruction HU's also were subtracted from recent HU's to determine the loss or gain of the potential of the habitat to support the target species 16 years after project construction. When the number of HU's lost or gained at post-construction was different from the number of HU's lost or gained at the recent time period, the reason for the difference (such as revegetation of an area that was disturbed during construction) was determined and documented. The HU's lost or gained represent the change in the potential of the habitat to support the given species at one point in time. That potential, however, was lost or gained over the entire life of the project. To simplify the loss statement and loss/gain accounting process, the loss or gain at the recent time period was used in the report sumnary.

Other factors such as density estimates, impacts not directly affecting habitat quality, and impacts resulting from other causes were analyzed when information was available and are discussed in the text of this report. Losses incurred from construction and operation of the project were considered relative to benefits.

IV. RESULTS AND DISCUSSION

A. Vegetation Cover Types

1. Descriptions

Seventeen cover types were identified in the Hills Creek Project area and acreages within the affected area were calculated for each (Table 1, Figures l-3). The most prominent type of vegetation was temperate conifer forest which was divided into 3 vegetation cover types: open, closed, and old-growth. Major tree species in all three temperate conifer forest types were Douglas-fir and western hemlock. There were various inclusions of incense cedar, western red cedar, ponderosa pine, bigleaf maple, red alder, madrone, and Oregon white oak, depending on moisture, slope, aspect, elevation, soils, and past disturbance. Crown closure was the criterion used in distinguishing among the 3 conifer types.

a. Temperate conifer forest, open

Open temperate conifer forest stands comprised about 5% of the affected area prior to project construction and about 1% after construction. Overstory crown closure was less than 70% and often these stands were in areas where selective cutting or other disturbance had occurred. Most stands were composed of large pole and sawtimber, with a dense under-story of shrubs and regeneration of conifers and hardwoods.

Table 1. Acreages of cover types within the affected area[1/] during preconstruction, postconstruction and recent conditions, and losses and gains in acreages from preconstruction to post-construction and preconstruction to recent conditions, Hills Creek Reservoir, Oregon.

Vegetation Cover Type/ Map Category	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (-,+)	
				Pre to post-construction	Pre to Recent
	Acres	Acres	Acres		
Tempeate conifer forest, open	220	54	180	-166	-40
Temperate conifer forest, closed	254	24	63	-230	-191
Temperate conifer forest, old-growth	3,136	442	442	-2,694	-2,694
Conifer-hardwood forest	186	105	84	-81	-102
Deciduous hardwoods (oak)	0	4	5	+4	+5
Riparian shrub	13	6	2	-7	-11
Riparian hardwood	211	13	15	-1%	-1%
Shrubland	18	105	264	+87	-246
Grass-forb	159	140	301	-19	+142
Coniferous wetland	0	17	20	+17	+20
Sand/gravel/cobble	75	6	4	-69	-71
Disturbed/bare/rock	49	1,003	530	+954	+481
Residential	13	4	4	+4	+4
Agricultural, cropland	122	0	0	-122	-122
Agricultural, pasture	49	0	0	-49	-49
River	157	29	38	-128	-119
Reservoir	0	2,710	2,710	+2,710	+2,710
TOTALS	4,662	4,662	4,662		

1/ The "affected area" was the area directly affected by project construction and operation, and included the reservoir, project facilities, staging areas, and relocated roads.

b. Temperate conifer forest, closed

Stands of closed temperate conifer forest varied from pole-sized trees to large sawtimber, but in all cases crown closure was 70% or more over the major part of the mapped stands. No attempt was made to distinguish between young and old stands because of study time limitations. In general, however, closed stands on the north side of the Hills Creek Arm were small sawtimber or poles, while those elsewhere in the study area were large sawtimber. Understory vegetation was restricted to ferns and herbs, with very few shrubs present and little conifer regeneration. The affected area consisted of 5% closed conifer stands prior to construction and less than 1% after construction.

C. Temperate conifer forest, old-growth

This was the most widespread vegetation cover type in the Hills Creek Reservoir study area prior to construction, comprising over 67% of the affected area. After construction, old-growth made up about 9% of the affected area. Old-growth stands were characterized by decay, numerous snags, canopy openings, and abundant dead and down woody material. Overstory trees were large in diameter and the tree canopy often consisted of 2 or more stories (Hall et al. 1985).

d. Conifer-hardwood forest

These stands were mixtures of conifers and hardwoods (e.g., red alder, biglead maple, madrone) with the latter contributing 30-70% of the crown cover (Hall et al. 1985). In the Hills Creek Reservoir study area, these stands were most common in the lower river valley near the dam site, particularly during preconstruction. Although conifer-hardwood forests are often seral to temperate conifer forests, some of the mapped stands in the study area may, due to site characteristics, be stable communities. These included a stand at the Packard Creek Campground which appeared on all three maps and (possibly) some stands on the north side of the Hills Creek Arm. Oregon white oak and madrone were the most abundant hardwoods in stands on higher slopes in the study area, while red alder was more commonly seen in stands along the river. The affected area contained 4% conifer-hardwood forest prior to construction and 2% after construction.

e. Deciduous hardwoods (oak)

Generally, Oregon white oak was a minor component of other communities (e.g., the conifer-hardwood stands described above). One small stand of pure oak was found, however, below Hills Creek Dam. Crown closure was nearly complete and understory vegetation appeared to be restricted to grasses and forbs.

f. Riparian shrub

This category was limited to shrubby areas along the banks of the river and on sand and gravel bars, and comprised less than 1% of the study area during all mapped time periods. Vegetation consisted of seedling willows and black cottonwood, with sparse herbaceous growth. Most of the riparian shrub stands should be considered ephemeral, as they occurred where high water could erode them away after a few years. A few stands might develop into riparian hardwood communities, depending on channel changes.

g. Riparian hardwoods

Black cottonwood was an important component of this cover type. Other deciduous species were sometimes present, as were conifers. No particular cover limits were assigned to black cottonwood. At Hills Creek Reservoir, riparian hardwoods occurred on alluvial stream terraces above the reservoir and along the river below the dam. These stands appeared to be seral stages of temperate conifer or conifer-hardwood forests, although flooding and channel changes could maintain the species composition for extended periods. Stands where black cottonwood were more than 15 feet tall and in greater abundance than red alder were included in this category. The affected area contained 5% riparian hardwood prior to construction and less than 1% after construction.

h. Shrubland

The affected area contained less than 1% shrubland prior to construction and 2% following construction. Shrub communities had 40% or more woody crown cover but woody vegetation was less than 15 feet tall (Hall et al. 1985). Often shrub communities were dominated by seedling conifers and were a seral stage in the regeneration of the temperate conifer forest. In some cases, however, shallow soils or steep, unstable slopes may have prolonged the shrub stage indefinitely. Such was probably the case along the east side of Hills Creek Reservoir at Big and Little Willow Creeks, where little change occurred between 1954 and 1979.

i. Grass-forb communities

Two types of grass-forb communities were mapped in the Hills Creek Reservoir study area. Most map units in this category represent the first stage of revegetation of disturbed areas. They occurred downslope of the road around the reservoir. Woody plant cover was less than 40% (Hall et al. 1985). Tree seedlings were usually present. The other type of grass-forb community may denote areas with shallow soils overlying rock. Practically no shrubs or tree seedlings were present. The grass-forb cover type comprised 3% of the affected area prior to construction and directly after construction, and 6% in 1979.

j. Red alder

Stands dominated by red alder were rare in the Hills Creek Reservoir study area. The only ones identified occurred near the junction of the Hills Creek Road with Highway 58, outside of the affected area. They

were composed of densely packed pole-sized trees with an understory of blackberry and forbs.

k. Coniferous wetlands

A small patch of coniferous wetland occurred just below Hills Creek Dam in an area that underwent moderate clearing and disturbance during dam construction. Western red cedar was the dominant tree, with salmonberry and red osier dogwood in the understory. The ground was irregular and channeled, with cattail and a large grass in the channels. Preconstruction aerial photographs show the area to be an old meander scar occupied by conifer-hardwood forest, probably predominately red alder, western red cedar, and black cottonwood. The substrate was most likely well-drained alluvium, subject to occasional flooding. Subsequent river rechannelization and bank stabilization altered drainage patterns so that the area now acts as a retention basin for runoff from nearby slopes and roads. Several of the meander scars appearing on the preconstruction map may have been occupied by similar wetlands, rather than the conifer-hardwood forest or riparian hardwoods shown. This would have depended on frequency of flooding and soil drainage conditions. It was not possible, due to quality and scale of 1944 aerial photographs, to determine whether wetlands were present prior to construction.

1. Sand/gravel/cobble

These areas occurred along the river and are probably under water during spring runoff and other periods of high water. Their extent would therefore vary with river level. They comprised about 2% of the affected area prior to construction and less than 1% after construction. They may have supported sparse herbaceous growth, but did not show signs of being heavily vegetated on aerial photographs.

m. Disturbed/bare/rock

This map category included Hills Creek Dam and roads, as well as areas where severe or continued disturbance prevented the reestablishment of vegetation. The affected area contained 1% of this cover type prior to construction, 22% directly after construction, and 11% in 1979.

n. Residential

This map category included rural residences, outbuildings, and other structures within the study area and comprised less than 1% of the affected area.

0. Agricultural, cropland

Before Hills Creek Dam was built there were several farms in the area. However, only two areas showed signs of regular cultivation. One of these was in the pool area; the other is presently in industrial use and is mapped as disturbed.

p. Agricultural, pasture

These areas were iaentified by evidences of past cultivation or by the presence of fencelines. Some areas mapped as grass-forb may have been used for grazing.

q. River

The area in this category included the main river channel only. Tributaries were too narrow to show up on the map and/or aerial photographs and therefore were not included in the acreage figures. River comprised over 3% of the affected area prior to construction and less than 1% after construction.

r. Reservoir

The area mapped as reservoir included the full pool level of the reservoir. During lower water levels, the drawdown zone, with a maximum vertical range of 129 feet, is exposed. Fluctuating water levels have not been conducive to the establishment of vegetation within this zone. Except for approximately 100 acres of annual rye grass seeding at the upper end of the reservoir and a 6-acre trial planting of cypress, willow, and sedge, the drawdown zone is barren during low water levels. The reservoir makes up 58% of the affected area.

2. Changes resulting from the project

Hills Creek Reservoir inundated 2,710 surface acres. The actual land base lost was, of course, greater than the reservoir surface acreage. Over 8 miles of the Middle Fork Willamette River and an undetermined number of miles of tributary streams were inundated. Surrounding land was altered by relocated roads, project facilities, and construction activities. Cover types reduced in acreage were old-growth conifer forest, riparian hardwood, open and closed conifer forest, conifer-hardwood forest, agricultural cropland and pasture, sand/gravel/cobble, and river (Table 1). Considerably more old-growth (2,694 acres) was eliminated than any other cover type. Old-growth forests in the Pacific Northwest support diverse and abundant wildlife populations and provide optimum habitat for up to 18 bird and mammal species (Meslow et al. 1981). The reduction of old-growth stands in the Pacific Northwest is of serious concern to wildlife managers. Riparian vegetation associated with rivers and streams is also considered to be of importance by wild-life managers. Riparian habitat is generally thought to provide for higher density and diversity of wildlife than most other habitats. Over 195 acres of riparian hardwood stands were eliminated within the area directly affected by the Hills Creek Project. In addition, a reduction of riparian habitat downstream from the project may have occurred as a result of the Hills Creek Project and/or effects of the Willamette Reservoir System. The effects of the loss of the previously mentioned cover types within the area directly affected by the project is discussed in greater detail in the Target Species sections of this report.

Cover types which increased within the affected area included the reservoir, disturbed/bare/rock, coniferous wetland, deciduous hardwood, and grass-forb. As a result of natural revegetation and succession during the years following project construction, disturbed/bare/rock and conifer-hardwood forest cover types developed into open conifer forest, closed conifer forest, grass-forb, and shrubland on about 500 acres of the area surrounding the reservoir.

Changes have occurred in the Willamette Basin since the time of project construction as a result of increased timber harvest and increased human development. It has not been possible to estimate how much of the area directly affected by the project might have been logged if the project had not been constructed. Timber management plans for the area prior to project construction could not be found. It is not possible to predict how management of the area would have been different without the project. The potential to manage the area for wildlife would exist if the project had not been constructed. Because the project was constructed, the potential for the inundated area to support many species of wildlife was eliminated.

B. Target Species

1. Roosevelt elk

a. Importance

The Roosevelt elk is a major big game species in western Oregon. Approximately 51,216 hunters participated in seasons for Roosevelt elk in 1983. The Indigo Wildlife Management Unit, in which the project is located, provided 9,663 hunter-days of recreation during the 1983 elk hunting seasons (Ingram 1984). Roosevelt elk require a variety of habitat types for survival, from open areas to old-growth forest (Witmer et al. 1985). The Roosevelt elk was chosen as a target species for this study because of management emphasis, recreational value, loss of winter range due to the project, and to represent other species with similar habitat requirements.

b. Habitat requirements

Open areas such as clear-cuts or burned areas, and natural openings found along streams or in old-growth forests provide elk forage such as grasses, forbs, and shrubs (Mace 1956, Swanson 1970, Cleary 1976, Witmer and deCalesta 1983). Critical to elk use of open forage areas is the proximity to cover. Elk use of open areas begins to decrease beyond 200 feet and decreases rapidly beyond 600 feet from cover (Kitmer et al. 1985). Forest stands provide escape cover as well as thermal relief from temperature extremes (Mace 1956; Harper 1966, 1971; Witmer and deCalesta 1983). Sapling-pole forests provide security during hunting seasons and thermal relief during the warm summer months (Mace 1956, Witmer and deCalesta 1983). Old-growth forests provide reduced snow depths and maintenance forage during severe winter weather in addition to escape and thermal cover (Starkey et al. 1982, Witmer and deCalesta 1983, Witmer et al. 1985). Snow depths of 18 inches or more can impede elk movement and bury most forage in forest openings, therefore, old-

growth stands are particularly important to elk during winter periods of deep snow (Witmer et al. 1985). Riparian habitat characterized by mixed conifer and hardwood vegetation is important to elk as a source of forage, as a place for loafing, for use as a travel corridor, and as a source of water (Starkey et al. 1982, Witmer and deCalesta 1983).

Use of plant species for forage varies with the seasons. Green grasses and forbs are heavily used by Roosevelt elk in spring and summer. Browse species are more important in late summer, fall, and winter (Mace 1956; Harper 1966, 1971). Vegetation use depends upon availability, but several species such as huckleberry, vine maple, salal ceanothus willow, and blackberry are important food sources for Roosevelt elk (Mace 1556; Harper 1966; Swanson 1970; R. Jubber, ODFW, E. Harshman, USFS, pers. cornmuns.).

C. History in the project area

Elk were widespread throughout the Willamette Valley during the 1800's. Settlement and unrestricted hunting had decimated the elk population by 1900 (Mace 1956, Starkey et al. 1982). Beginning in 1905, elk hunting was not permitted in Oregon. By the mid-1930's, elk damage complaints indicated some populations of elk could support a limited harvest and in 1938 Roosevelt elk were hunted for the first time since the closure (Mace 1956).

Estimates made of the Oregon elk population in 1932 indicated 800 animals in the Cascade Range, and 400 elk within Lane County (in both the Coast Range and Cascade Range) (Oregon State Game Commission [OSGC] 1933). In 1953, OSGC initiated a program to increase the number and distribution of Roosevelt elk in western Oregon (Mace 1971). By 1967, the estimated Roosevelt elk population in the Willamette Basin was 2,000 animals, the majority of which were found in the McKenzie and Middle Fork Willamette River drainages (Aney 1967). The increase in elk numbers is mostly attributed to the increase in timber harvest in the Willamette Basin at that time.

Information is limited on elk populations in the project area prior to construction. Although elk populations were generally at a low level during the preconstruction period, "small numbers of Roosevelt elk utilized the area as winter range" (USACE and USFS 1968). Due to logging in the Hills Creek area, elk use has increased since the project was constructed. Six herds of 20-50 animals each currently use the project area and adjacent land during winter. The relatively mild climatic conditions in the Middle Fork drainage in and surrounding the Hills Creek Project area make it particularly valuable as winter range (R. Jubber, ODFW, pers. commun.). Periods of heavy snowfall do occur in the area. In 1950 and 1969 snow depths over 18 inches remained longer than 15 days at McCredie Springs, which is about about 5 miles west of the Hills Creek Reservoir. Most deer and elk that survived the January 1969 storm were found in large sawtimber or old-growth forest stands where dominant trees averaged 21 inches dbh or greater and had 70% or greater crown closure (E. Harshman, USFS, pers. commun.).

d. Assessment of impact

Prior to project construction, 4,368 acres of open, closed, and old-growth conifer forest, conifer-hardwood forest, riparian shrub and hardwood, shrubland, grass-forb, and agricultural cover types were available to elk for winter use in the affected area (Table 2). Old-growth forests provided cover and maintenance forage for elk during winter. Open foraging areas were limited, reducing the potential of the habitat for supporting large numbers of elk for an extended period of time. The importance of the area as winter range contributed to the value of the habitat prior to project construction. The suitability of this elk winter range was given a rating of 8 (high) by the interagency evaluation group. Following the impact analyses methods described in Section III.E., the rated value of the habitat (8) was divided by the optimum potential value (10) resulting in a habitat suitability index of 0.8. The habitat suitability index was then multiplied by the number of acres of habitat available (4,368), resulting in a habitat unit (HU) value of 3,494. One HU is equivalent to 1 acre of optimum habitat, therefore, the 4,368 acres of elk habitat within the affected area prior to construction were equivalent to 3,494 acres of prime elk habitat.

Upon completion of project construction, 910 acres of habitat were available to elk in the affected area (Table 2). The most important loss was in old-growth and riparian cover types. The interagency evaluation group rated postconstruction habitat for elk 1 (low), considering recent project construction activity and associated disturbance. The relative value of the postconstruction elk habitat in the affected area was 91 HU's, a loss of 3,403 HU's from the preconstruction value.

By 1979, 1,456 acres of habitat were available to elk. The increase in habitat was due to natural revegetation and seral advancement in the affected area. The suitability of the habitat as winter range was raed 2 (poor) by the evaluation group. Despite the increase in potential habitat, the value remained low because the affected area did not provide more than minimal cover or forage conditions. In addition, the roads bisect available habitat and human disturbance limited use of the area. The relative value of the elk habitat was 291 HU's, a loss of 3,203 HU's when compared to the preconstruction value of the affected area (Table 2). The decline in HU's represents a loss in the potential of the project area to support elk and other wildlife species with similar habitat preferences or requirements.

The impounded area was identified as significant winter range for Roosevelt elk in a report by USACE and USFS (1968). Elk currently use the Middle Fork drainage above and below the reservoir as winter range and presumably would have used the reservoir site also. Elk presently migrate to the reservoir area from several adjacent drainages (Packard Creek, Buck Creek, Modoc Creek, Big Willow Creek) and may have used the same or different routes prior to construction. Current migration patterns indicate that elk migration may have been inhibited and/or blocked by the reservoir. The resulting effect can be direct mortality during severe winter weather conditions or at least additional

Table 2. Roosevelt elk: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Temperte conifer forest, open	220	54	180	-166	-40
Temperate conifer forest, closed	254	24	63	-230	-191
Temperate conifer forest, old-growth	3,136	442	442	-2,694	-2,694
Conifer-hardwood forest	186	105	84	-81	-102
Deciduous hardwood (oak)	0	4	5	+4	+5
Riparian shrub	13	6	2	-7	-11
Riparian hardwood	211	13	15	-1%	-1%
Coniferous wetland	0	17	20	+17	+20
Shrubland	18	105	264	+87	+246
Grass-fork	159	140	301	-19	+142
Agric., coprland	122	0	0	-122	-122
Agric., pasture	49	0	0	-49	-49
TOTAL ACRES	4,368	910	1,456	-3,458	-2,912
Habitat Rating	8	1	2		
HABITAT UNITS	3,494	91	291	-3,403	-3,203

expenditure of energy by elk during winter when energy conservation is most important.

The relocated roads adjacent to Hills Creek Reservoir receive logging traffic and provide access to recreationists. In addition to the loss or degradation of habitat, these roads can result in increased road kills, poaching, or disturbance, resulting in greater energy expenditures or total avoidance of the area by elk and deer.

2. Black-tailed deer

a. Importance

Black-tailed deer are pursued by more hunters than any other big game species in western Oregon. Deer hunting provided 54,358 hunter-days of recreation in the Indigo Wildlife Management Unit during 1983 (Ingram 1984). Black-tailed deer prefer a variety of habitat types, from open areas to old-growth forest (Witmer et al. 1985). With inundation of the Hills Creek Project site, year-round habitat and important deer winter range was lost (USACE and USFS 1968). The black-tailed deer was chosen as a target species for this study because of management emphasis, recreational value, loss of habitat due to the project, and to represent other species with similar habitat requirements. The black-tailed deer is a major big game species in Oregon and has different specific habitat requirements and preferences than elk. Therefore, black-tailed deer was selected as a target species in addition to Roosevelt elk, even though many basic habitat requirements are similar.

b. Habitat requirements

Black-tailed deer are associated with open areas, such as burns, clear-cuts, and natural openings found along streams or in old-growth forests, as well as brush and edge habitat (Mace 1953, Aney 1967). These areas produce the grasses, forbs, and shrubs upon which deer forage. The value of these forage areas for deer is dependent upon the proximity to cover. Black-tailed deer remain near the edge between cover and open areas. Deer use of open forage areas increases from the edge to 200 feet, then gradually decreases beyond 200 feet, and decreases rapidly beyond 600 feet from cover (Wilms 1971, Witmer et al. 1985). Hanley (1983) observed peak deer use of the open forage area approximately 550 feet from cover. Old-growth forest stands are used by deer forhiding cover and during adverse weather conditions for supplemental forage and thermal cover (Lindzey 1943, Witmer et al. 1985). Old-growth stands are, therefore, especially important to deer during periods of deep snow when depths of 18 inches or more impede deer movement and bury most forage in forest openings (Witmer et al. 1985). Riparian zones provide water, forage, and shade, and are used as travel corridors by black-tailed deer. Riparian habitat receives greater use during fawning periods, dry summer months, and times of heavy snowfall (Witmer et al. 1985).

Use of plant species by black-tailed deer for forage varies depending on the season and availability. Wallmo (1981) conducted a study west of Corvallis, Oregon, and found that browse species were most frequently used, forb use increased in spring and summer, and grasses were consumed consistently in winter. Browse species such as trailing blackberry, huckleberry, and salal are important to black-tailed deer in the Coast Range (Lindzey 1943; Brown 1961; Miller 1966, 1968; Hines undated). The primary browse for black-tailed deer in the Cascade Range, Rigdon Ranger District, is ceanothus. The most important species of ceanothus are deerbrush, restem, and snowbrush (R. Jubber, ODFW, pers. comnun.). Some of the highest quality deer winter ranges in the central and south Cascades constain one or more of these species (E. Harshman, USFS; R. Jubber, ODFW, pers. communs.).

C. History in project area

Information available on deer populations in the project area prior to construction is limited. According to USFWS (1958), deer numbers were high and were increasing as a result of logging in the area. OSGC (1948) estimated 5 deer per square mile along the Middle Fork Willamette River in 1948. Increased timber harvest and improved forage within the drainage at the time of construction probably provided for a larger population than this estimate indicates (R. Jubber, ODFW, pers. commun.). Forty to 50 deer per square mile may be a more accurate estimate (R. Jubber, ODFW, pers. commun.)., The deer population in the Willamette Basin peaked between 1955 and 1960 (Aney 1967).

In 1967, the estimated black-tailed deer population within the Willamette Basin was 135,000 (Aney 1967). ODFW estimated the black-tailed deer population in Lane County in 1980 was 92,100 animals. With approximately 4,200 square miles of deer habitat within the county, the estimated density was 22 deer/square mile of habitat (ODFW files). Current estimates are about 40 deer/square mile in the area surrounding the project site (J. Greer, ODFW, pers. commun.).

d. Ass sment of impact

Prior to project construction, 4,368 acres of open conifer, closed conifer, old-growth forest, conifer-hardwood, riparian shrub, riparian hardwood, shrub land, agricultural, and grass-forb vegetation cover types were available to black-tailed deer within the affected area (Table 3). The interagency evaluation team rated the suitability of the year-round habitat 7 (above aver age), resulting in a value of 3,058 HU's. The interspersion of open areas and cover and the availability of forage was not optimum for deer. The old-growth forest and riparian habitat present within the reservoir site was important winter range for deer. The affected area provided good quality thermal cover which was important during the critical winter period. Deer could migrate up and down the Middle Fork Willamette drainage, which was used as a travel corridor.

Table 3. Balck-tailed deer: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or qain (+ or -) Pre- to POst-construction	Loss or qain (+ or -) Preconstruction to recent
Temperate conifer forest, open	220	54	180	-166	-40
TEmperate conifer forest, closed	254	24	63	-230	-191
Temperate conifer forest, old-growth	3,136	442	442	-2,694	-2,694
Conifer-hardwood forest	1%	105	84	-81	-102
Deciduous hardwood (oak)	0	4	5	+4	+5
Riparim shrub	13	6	2	-7	-11
Riparim hardwood	211	13	15	-198	-1%
Coniferous wetland	0	17	20	+17	+20
Shrubland	18	105	264	+87	+246
Grass-for-b	159	140	301	-19	+142
Agric., cropland	122	0	0	-122	-122
Agric., pasture	49	0	0	-49	-49
TOT/X ACRES	4,368	910	1,456	-3,458	-2,912
Habitat Rating	7	1	1		
HABITAT WITS	3,058	91	146	-2,967	-2,912

In 1964, upon completion of the project, 910 acres of black-tailed deer habitat remained within the affected area. The lack of forage and cover and recent disturbance from project construction activities contributed to a suitability rating of 1 (low). A loss of 2,967 HU's resulted from construction of the project, with the remaining habitat having a value of 91 HU's.

Available black-tailed deer habitat increased to 1,456 acres by 1979 as a result of natural revegetation. The evaluation team rated this habitat 1 (low) which resulted in 146 HU's. This was a loss of 2,912 HU's compared with the preconstruction value. The available habitat within the affected area still lacked quality forage and cover. Relocated roads bisected available habitat, and increased accessibility and human activity reduced the value of the habitat within the affected area for black-tailed deer. The decline in HU's represents a loss in the potential of the project area to support black-tailed deer and other wildlife species with similar habitat requirements. The loss of habitat as a result of inundation was "particularly significant because it was winter range for both black-tailed deer and Roosevelt elk" (USACE and USFS 1968).

3. Black bear

a. Importance

The black bear has been classified as a game mammal in Oregon for the past 20 years and provides recreation for sportsmen during harvest and pursuit seasons. ODFW collected over $150,000 in bear tag fees from 26,753 hunters in 1984 (ODFW files). Black bears prefer forest edge habitat and mature forests for denning sites (Aney 1967, Lindzey 1976, Herrero 1977). With inundation of the Hills Creek Project site, a variety of habitats used by black bears were lost. The black bear was selected as a target species for this study because of recreational value, habitat requirements, and loss of habitat due to the project.

b. Habitat requirements

Black bears are primarily adapted to forest ecosystems and their edges and clearings (Herrero 1977). Their preferred habitat is forest with numerous openings, glades, and edges (Aney 1967, Herrero 1977). Important communitie for black bears include subclimax and early successional brushfields, wet and dry meadows, riparian areas, and various mixed and pure stands of mast or fruit producing hardwoods (Lawrence 1977). Coniferous forest provides security for bears in the form of hiding cover, travel corridors, and bedding and denning sites (Lindzey 1976, Jonkel 1978). Observations made during studies in southwestern Oregon indicated 74% of bear sightings were in conifer and Douglas-fir/broadleaf forests, 14% in clearcuts, and 8% in brushfields (McCollum 1973). Early seral plant communities, such as clearcuts and natural openings provide concentrations of foods for bears (Lindzey 1976, Lindzey and Meslow 1977). Although bears are attracted to open areas as sources of food, they will not venture far from cover, and remain within 350 yards of the forest edge (McCollum 1973, Lawrence 1977). Riparian areas are important for bears, providing a variety of

foods during all seasons, as well as serving as travel corridors (Lawrence 1977, Jonkel 1978). Black bear dens are often located at the base of standing trees or snags, in hollow trees, under windfalls, in caves, or underground (Lawrence 1977, Maser et al. 1981). Black bears are opportunistic feeders and will consume green vegetation, fruits, nuts, fungi, invertebrates, mammals, birds, fish, and carrion (Beebe and Johnson 1965, Ingles 1965, Herrero 1977, Lawrence 1977, Jonkel 1978).

C. History in the project area

The historical status of black bears in Oregon has varied. Unrestricted or liberal hunting seasons and damage control characterized OSGC's management of black bears until the 1970's (Lindzey 1976; Ebert 1977, 1979). The Oregon bear population reached its highest level before 1940 and has gradually declined since then (Aney 1967). The Willamette Basin bear population was estimated at 14,000 in 1967 (Aney 1967). ODFW estimated 3,500 black bears occupied 3,700 square miles of habitat within Lane County in 1980 (ODFW files).

Information is limited on black bear populations in the project area prior to construction. Black bears were present in the impoundment area, although in low numbers (USFWS 1958; USACE and USFS 1963, 1968).

d. Assessment of impact

Most of the affected area was available habitat for black bears prior to construction of the Hills Creek Project (Table 4). The suitability of the 4,429 acres of habitat was given a rating of 7 (above average) for a value of 3,100 HU's. The river bottom provided forage and a travel corridor of protective cover. Habitat meeting the reproductive requirements of black bears was near optimum within the affected area and human disturbance was minimal. The affected area was characterized by a contiguous stretch of old-growth forest and lacked a high diversity of cover types and open areas, which prevented assessment of a higher rating.

Following completion of the project, 945 acres of black bear habitat remained within the affected area (Table 4). Black bears probably avoided the area entirely due to the disruption of the habitat and high human disturbance. The habitat was therefore given a rating of 1 (low;, which resulted in a value of 95 HU's. This was a reduction in value of 3,005 HU's from preconstruction.

By 1979, natural revegetation had slightly increased the acreage of available black bear habitat within the affected area to 1,418 acres, but it was still considered poor by the evaluation team and rated 1 (Table 4). The remaining habitat within the affected area occurred in small, isolated pockets subject to high disturbance. The recent black bear habitat value of 142 HU's was a loss of 2,958 H:'s from the preconstruction value. The decline in HU's represents a loss in the potential of the project area to support black bear and other wildlife species with similar habitat requirements.

Table 4. Black bear: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Temperate conifer forest, open	220	54	180	-166	-40
Temperate conifer forest, closed	254	24	63	-230	-191
Temperate conifer forest, old-growth	3,136	442	442	-2,694	-2,694
Cinifer-hardwood forest	186	105	84	-81	-102
Deciduous hardwood (oak)	0	4	5	+4	+5
Riparian shrub	13	6	2	-7	-11
Riparian [illegible]	211	13	15	-198	-1%
Coniferous wetland	0	17	20	+17	+20
Shrubland	18	105	264	+87	+246
Grass-for%	159	140	301	-19	+142
Sand/gravel/cobble	75	6	4	-69	-71
River	157	29	38	-128	-119
TOTAL ACRES	4,429	945	1,418	-3,484	-3,011
Habitat Rating	7	1	1		
HABITAT UNITS	3,100	95	142	-3,005	-2,958

Dam construction in the Pacific Northwest is almost always detrimental to black bear populations, resulting in the loss of both food and cover (Lawrence 1977). Riparian habitat, which provided a variety of foods and served as a travel corridor for bears was eliminated. Relocated roads adjacent to Hills Creek Reservoir bisect available habitat and provide increased access to the site for recreationists, resulting in increased disturbance.

4. Cougar

a. Importance

The cougar has had an important place in wildlife management in Oregon as both a predator and big game species. Cougars had been managed on a bounty basis, but more recently have attained trophy status. Cougars are also important because of their interrelationship with deer and elk, which are primary prey species (Seton 1953, Ingles 1965, Hornocker 1970, Russell 1978). Cougars may be a factor in deer and elk dispersal on winter ranges (Hornocker 1970). The cougar was selected as a target species to represent a large carnivore and because of recreational value, low tolerance of human activity, and the impact of the project on the habitat of cougar and their prey.

b. Habitat requirements

Cougars in Oregon are associated with rough, mountainous terrain and forests with abundant deer populations (Aney 1967, Russell 1978). Some of the highest densities of cougars in Oregon occur in the Indigo Wildlife Management Unit where the predominate habitat type is Douglas-fir/trailing blackberry with clearcut units surrounded by old-growth forests (Harcombe 1976). Cougars prefer primitive habitat where human activity is minimal or absent (Young and Goldman 1946, Aney 1967, Russell 1978). In Lane County cougars are found in the foothills near settled areas where prey is abundant (R. Carleson, R. Jubber, ODFW, pers. communs.). Cougars generally bed under cover of rock, in caves, or in hollow trees (Seton 1953, Russell 1978). Females seek concealment in a secure location such as rocky depressions, shallow caves, rock overhangs, uprooted trees, or in dense thickets for parturition (Russell 1978, Maser et al. 1981). Trees, steep bluffs, and caves provide cover (Hornocker 1970).

Old-growth forest and clearcut areas which support populations of black-tailed deer and Roosevelt elk provide good habitat for cougars (Harcombe 1976). Old-growth forest is important hunting habitat for cougars (Hornocker 1970, Harcombe 1976). Winter observations by Harcombe (1976) indicated cougars remained in the vicinity of old-growth timber and seldom ventured through expanses of second-growth Douglas-fir. Several cougar sightings in Lane County have been in 0 to 15-year-old clearcut units within 1/2 mile of mature forest where the cougars were observed hunting or guarding a kill (R. Jubber, ODFW, pers. commun). Deer and elk comprise the major portion of the cougar diet, and deer are considered their dietary staple (Ingles 1965, Hornocker 1970, Toweill and Meslow 1977, Russell 1978). Small mammals

also comprise part of the cougar diet (Ingles 1965, Toweill and Meslow 1977).

C. Yistory in the project area

Historically, cougars were probably once present throughout the entire Willamette Basin, but their presence was not compatible with early settlement of the area (Young and Goldman 1946, Aney 1967). As a result, the statewide cougar population declined until the late 1960's. In 1968 the cougar was declared a game animal and harvest was limited to damage control situations (Harcombe 1976). In 1970, the first cougar tags were issued for a recreational harvest season (Harcombe 1976).

Estimates made in 1980 for Lane County included 3,700 square miles of cougar habitat and a population of 310 cougars (ODFW files). Cougar are seen occasionally along Kitson Ridge east of the reservoir (K. Kestner, USFS, pers. commun.).

d. Assessment of impact

Cougars were assumed to use the same vegetation cover types as deer and elk, their primary prey, with the exception of agricultural lands (Table 5). The interagency evaluation team rated the 4,197 acres of cougar habitat available prior to project construction 6 (above average), for a value of 2,518 HU's. Use of the area by deer, particularly during the winter, was considered when rating the value of the site for cougars. The expanse of old-growth forest and minimal amount of habitat diversity kept the suitability rating at no higher than above average for deer and therefore limited the suitability of the area for cougar.

Upon completion of the project, 910 acres of habitat were available for cougars within the affected area. The concentration of human activity at the project site and lack of prey probably caused cougars to avoid the area entirely. The evaluation team rated the habitat 1 (low), for a value of 91 HU's a reduction of 2,427 HU's from the preconstruction value.

Cougar habitat available in 1979 totaled 1,371 acres. The evaluation team considered the habitat to be of minimum quality for cougars and rated the habitat 1, for a value of 137 HU's. This was a loss of 2,381 HU's from preconstruction conditions. The decrease in HU's represects a loss in the potential of the project area to support cougar and other wildlife species with similar habitat requirements. Cougars follow deer onto their winter range, but the affected area lacked winter thermal cover and maintenance forage needed by deer. Increased road traffic and human disturbance had a negative impact on both cougars and their prey.

5. River otter

a. Importance

Furbearers documented as using the reservoir site prior to project construction included river otter, beaver, mink, raccoon, and skunk

Table 5. Cougar: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construtin (1944)	Post-constructin (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent.
Temperate conifer forest, open	220	54	180	-166	-40
Temperate, conifer forest, closed	254	24	63	-230	-191
Temperate conifer forest, old-growth	3,136	442	442	-2,694	-2,694
Conifer-hardwood forest.	186	105	84	-81	-102
Deciduous hardwood (oak)	0	4	5	+4	+5
Riparian shrub	13	6	2	-7	-11
Riparina hardwood	211	13	15	-1%	-196
Coniferous wetland	0	17	15	+17	+15
Shrubland	18	105	264	+87	+246
Grass-for%	159	140	301	-19	+142
TOTAL ACRES	4,197	910	1,371	-3,257	-2,826
Habitat Rating	6	1	1		
HABITAT UNITS	2,518	91	137	-2,427	-2,381

(USFWS 1958). The river otter was selected as a target species for this study because of its economic and recreational value, dependence on aquatic and riparian habitat, loss of habitat as a result of the Hills Creek Project, and to represent other species with similar habitat requirements.

b. Habitat requirements

The river otter is a semiaquatic mammal dependent upon water and its associated riparian habitat for food, cover, and reproduction (LaDue 1935, Mace 1979, Deems and Pursley 1983). River otters use streams and mountain rivers ranging from 3-33 yards wide (Maser et al. 1981, Melquist and Hornocker 1983). During winter, otters seek fast-flowing streams free of ice (Mace 1979). Mudflats, open marshes and swamps, and backwater sloughs are used more often by otters during the summer months (Melquist and Hornocker 1983).

River otters use abandoned burrows of other animals as den sites (Mace 1979, Rue 1981, Toweill and Tabor 1982). Beaver houses or dens are used most often. Otter will also use muskrat houses and dens located near water (Mace 1979, Rue 1981, Toweill and Tabor 1982). These dens are usually renovated and enlarged by otters (Ingles 1965, Maser et al. 1981). Dens selected by river otters may be as far as l/2 mile from water (Maser et al. 1981, USFS 1981a). Parturition may occur in dens or cavities among roots of trees, brushpiles, thickets of vegetation, under streambanks, or in hollow stumps or logs (Liers 1951, Mace 1979).

Principal food of the river otter is fish (Rue 1981, Toweill and Tabor 1982, Deems and Pursley 1983). They are opportunistic feeders, and select those fish species most abundant and/or easiest to catch (Toweill and Tabor 1982, Melquist and Hornocker 1983). Crayfish are an important year-round item in the otter diet (Maser et al. 1981, Toweill and Tabor 1982, Deems and Pursley 1983). In addition to fish and crayfish, the river otter diet includes amphibians, aquatic insects, small mammals, birds and eggs, and carrion. River otters also eat some vegetation such as berries, tubers, pondweeds, algae, and grasses (Sheldon and Toll 1964, Maser et al. 1981, Rue 1981, Toweill and Tabor 1982).

c History in the project area

River otters formerlv occupied nearly all permanent streams and lakes in Oregon (Mace 1979). Unregulated trapping was permitted until 1913, at which time the Oregon Legislature enacted comprehensive trapping laws for 5 species of fur-bearers, including river otter (Mace 1979).

River otters still occupy much of their original range but in lesser numbers due to reduced habitat and increased trapping pressure (Aney 1967, Mace i979). In 1967, the river otter population in the Willamette Basin was low, with an estimated population of 500 animals (Aney 1967). In 1980 the estimated otter population in Lane County was 850 animals over 985 linear stream miles (985 square miles) of habitat (ODFW files). Quantitative information on river otter populations in the project area prior to construction was not available.

d. Assessment of impact

Conifer-hardwood, riparian shrub, riparian hardwood, sand/gravel/cobble, and river cover types were available to river otters in the affected area prior to project construction (Table 6). The 576 acres of river otter habitat were given a suitability rating of 7 (above average) for year-round use. Forage was adequate and supplied primarily by resident fish. Denning sites were available. The existing road caused some disturbance. The large number of tributaries enhanced the quality of the habitat. The value of river otter habitat prior to project construction was 403 HU's.

After completion of the project, 201 acres of habitat were available to river otters. This included 100 acres of the reservoir used for foraging, primarily within the tributaries and along the edge of the reservoir. The largest loss of habitat was from riparian hardwood and river cover types. The suitability of the remaining habitat was rated 1 (low) by the evaluation team. Disturbance of the area had recently occurred and vegetation and prey base had not yet become established. The dam and reservoir inhibited river otter movement along the Middle Fork Willamette River. The value of the postconstruction otter habitat within the affected area was 20 HU's, a loss of 383 HU's from the pre-construction value.

The suitability of the 189 acres of habitat remaining in 1979 was rated 1 (low) by the evaluation team. Stocked trout, other available fish and crayfish probably provided an adequate food supply, but the exposed reservoir shoreline did not provide adequate cover or denning sites. Human activity had a negative effect on river otters, which was probably increased by the lack of cover in the reservoir area. River otter habitat in 1979 was valued at 19 HU's, a loss of 384 HU's from the pre-construction value. The decline in HU's represents a loss in the potential of the project area to support otter and other wildlife species with similar habitat requirements.

USFWS (1958) predicted limited furbearer use because of the fluctuating water levels. Research conducted in Idaho indicated Cascade Reservoir was virtually unused by river otters because there was insufficient escape cover and resting sites along the exposed shoreline even though there was a sufficient food source (Melquist and Hornocker 1383). This study also indicated that otters' tolerance of human activity was related to the amount of escape cover and shelter along a lake shoreline. The study concluded that the stream-related habitats were preferred to lakes, reservoirs and ponds because of the availability of shelter and escape cover and less disturbance.

Relocated roads adjacent to Hills Creek Reservoir receive logging traffic and provide access to recreationists. The effect on river otters may be direct mortality or increased disturbance, and thus lower quality habitat.

Table 6. River otter: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Conifer-hardwood forest*	120	30	10	-90	-110
Riparian shrub	13	6	2	-7	-11
Riparian hardwood	211	13	15	-198	-196
Coniferous wetland	0	17	20	+17	+20
Sand/gravel/cobble	75	6	4	-69	-71
River	157	29	38	-128	-119
Reservoir*	0	100	100	+100	+100
TOTAL ACRES	576	201	189	-375	-387
Habitat Rating	7	1	1		
HABITAT UNITS	403	20	19	-383	-384

*Represents a portion of total acres present.

6. Beaver

a. Importance

Beaver have an important place in Oregon's history, so much so that the species was selected as the state mammal Fur trade attracted the first white men to the Oregon territory, and beaver are still of economic value today. Beaver are dependent upon a relatively stable source of water and its associated riparian habitat for survival, where they create ponds and pools used by many species of fish and wildlife for rearing, feeding, and resting. The beaver was selected as a target species for this assessment because of historic and economic value, dependence upon riparian habitats, loss of habitat due to the project, and to represent other wildlife species with similar habitat requirements.

b. Habitat requirements

Slow-flowing streams, small streams or lakes surrounded by a fairly dense stand of deciduous trees, and some agricultural waterways and wetlands may be selected for colonization by beaver (Aney 1967, Mace 1979, Deems and Pursley 1983). A minimum of 0.5 miles of stream channel or 0.5 square miles of lake or marsh habitat must be available before an area is suitable for beaver colonization (Allen 1982). Beaver need a permanent and relatively stable water source (Allen 1982). Stream gradient, which may be the most significant factor in determining suitability of riverine habitat for beaver, must be less than 15% (Allen 1982). Beaver construct dams to stabilize water depths (Shay 1978, Mace 1979) and to create ponds which provide cover, feeding, and reproductive requirements (Rue 1981, Allen 1982, Deems and Pursley 1983).

A deciduous tree and/or shrub canopy closure between 40-60% is an indication of optimum food availability for beaver (Allen 1982). For maximum suitability, the diameter at breast height (dbh) of trees should range from l-6 inches, and shrubs should be at least 6 l/2 feet tall (Allen 1982). Tree and shrub species used include aspen, willow, cottonwood, alder, red osier dogwood, birch, maple, cherry, and poplar (Townsend 1953, Mace 1979, and Allen 1982). Beaver feed primarily on the bark and cambium layer of deciduous trees and shrubs, as well as the twigs and leaves. Small quantities of Douglas-fir, western hemlock, and Scotch broom also appear in the beaver diet (Maser et al. 1981). The majority of foraging occurs within 330 feet of the water's edge, and may extend to distances of 660 feet (Allen 1982). Aquatic vegetation is preferred and herbaceous vegetation appears to be preferred over woody vegetation (Allen 1982). Sedge and water lily rhizomes are consumed during the summer (Seton 1953, Townsend 1553, Allen 1982).

Beaver construct dens which fulfill their cover and reproductive needs (Allen 1982). Three basic forms of dens are constructed by beaver: a standing lodge in open water, a bank lodge with a burrow into the bank, and a burrow into the bank without a lodge (Ingles 1965, Allen 1982).

C. History in the project area

Quantitative information on furbearer populations in the project area prior to construction was not available. The reservoir site supported beaver, otter, mink, and raccoon (USFWS 1958).

Historical records indicate the Willamette Basin supported large beaver populations when the earliest trappers and explorers arrived in the early 1800's (Aney 1967). Beaver trapping in Oregon was restricted by a statewide closure in 1899 and did not resume until 1951 (Kebbe 1960, Shay 1978). Beaver populations had become seriously depleted due to over-trapping and habitat losses (Kebbe 1960, Shay 1978). In 1932, a program was begun to live-trap beaver from damage sites or areas of healthy populations and transfer them to suitable habitat in an effort to reestablish beaver in their historical habitat (Scheffer 1941, Kebbe 1960). The Willamette Basin beaver population was estimated at 10,000 in 1967 (Aney 1967). In 1982, ODFW estimated for Lane County beaver densities of 10 beaver per linear mile on rivers over 100 feet wide, 7 per linear mile on streams 20-1OQ feet wide, and 5 per linear mile on streams 8-20 feet wide (ODFW files).

d. Assessment of impact

Prior to inundation, 576 acres of conifer-hardwood, riparian shrub, riparian hardwood, sand/gravel/cobble, and river were available to beaver within the affected area (Table 7). The evaluation team rated the habitat 6 (above average) resulting in a value of 346 HU's. Although not optimum, the affected area provided adequate forage, with a high percentage of the riparian habitat in hardwoods. Rocky river banks were not good for denning, but woody material was available for lodge construction. The lack of slack water reduced the habitat quality somewhat.

Upon completion of the project, beaver habitat was reduced to 111 acres. This included 10 acres of reservoir. Beaver use of the reservoir is low, limited primarily to tributaries. Postconstruction habitat was rated 1 (low). Few hardwood species were available as forage, the wetland area was not yet established, and the area was recently disturbed. The habitat was valued at 11 HU's, a loss of 335 HU's from the preconstruction value.

The 99 acres of more recent (1979) habitat was given a rating of 2 (poor), resulting in a value of 20 HU's. This represents a loss of 326 HU's from preconstruction to recent conditions. The reservoir was considered poor beaver habitat by the evaluation team. Lakes and reservoirs having extreme fluctuations in water level are considered unsuitable beaver habitat (Allen 1982). Overall, forage availability was minimal and the affected area did not provide many denning sites. The only suitable habitat used by beaver was the small wetland below the dam.

The dam may not have completely blocked beaver dispersal along the river, but it probably inhibited beaver movement along the river. The major impact of the project was the loss of riparian hardwoods, the

Table 7. Beaver: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Conifer-hardwood forest*	120	30	10	-90	-110
Riparina shrub	13	6	2	-7	-11
Riparianhardwood	211	13	15	-198	-196
Coniferous wetland	0	17	20	+17	+20
Sand/gravel/cobble	75	6	4	-69	-71
River	157	29	38	-128	-119
Reservoir*	0	10	10	+10	+10
TOTAL ACRES	576	111	99	-465	-477
Habitat Rating	6	1	2		
HABITAT WITS	346	11	20	-335	-326

*Represents a portion of all acres available.

major food source of beaver. The decrease in HU's for beaver represents a loss in the potential of the project area to support beaver and other wildlife species with similar habitat requirements, and species which use the ponds and pools created by beaver.

7. Ruffed grouse

a. Importance

Upland game birds potentially affected by construction of the Hills Creek Project included ruffed grouse, blue grouse, mountain quail, and band-tailed pigeon. The ruffed grouse was chosen as a target species because of its recreational value, because of the impacts which occurred from the loss of riparian habitat as a result of the Hills Creek Project, and to represent other species with similar habitat requirements.

b. Habitat requirements

Thickets of alder, hawthorn, birch, maple, and other deciduous trees provide summer and fall habitat for ruffed grouse in Oregon (Masson and Mace 1974). Adjacent conifer stands are used for escape cover and winter shelter.

Spring, summer and fall diets of ruffed grouse in Oregon consist of a wide variety of leaves, grasses, forbs, berries, and buds (Durbin 1979). The availability of a winter source of birch, alder, hazel, or aspen catkins may be the most important factor influencing the survival of wintering ruffed grouse (Gullion 1966). In Oregon, Durbin (1979) reported that alder buds and catkins are probably the primary winter food. Black cottonwood (buds, twigs, catkins) and buttercup are the primary winter food items of ruffed grouse in western Washington (Brewer 1980).

Ruffed grouse chicks for the first 7-10 days primarily consume invertebrates (Johnsgard 1973), which are most available in mesic conditions such as found in riparian habitat. Ruffed grouse broods use semi-open areas characteristic of early stages of woodland succession (Sharp 1963). Small hardwoods, shrubs, berry bushes, and lush herbs provide habitat preferred by ruffed grouse broods (Bump et al. 1947). Once ruffed grouse chicks reach about. 4 months of age, closed-canopy forests are suitable habitat (Chambers and Sharp 1958).

Drumming sites are an important reproductive requirement of ruffed grouse. Drumming habitat may be either deciduous or mixed forest adjacent to fields, clear-cuts, or regrowth areas (Brewer 1980). Adequate nesting habitat is another reproductive requirement of ruffed grouse. Hardwood stands or mixed hardwoods are the most frequently used forest types for nesting (Edminster 1947, Maxson 1978). Nest sites are most often at the base of large trees, but some are located at the base of stumps, logs, or bushes, usually within 50 feet of clearings or fields (Edminster 1947).

C. History in the project area

Grouse populations were "large" in the project area prior to project construction (USFWS 1958). Quantitative information on grouse populations in the project area prior to construction was not available. The OSGC estimated 4 grouse per square mile in the Middle Fork Willamette watershed in 1948. That estimate was probably very low for the Hills Creek area during the 1950's and 1960's (R. Jubber, ODFW, pers. commun.). Current grouse densities in the project area are approximately 20 per square mile (J. Greer, OGFW, pers. commun.), but vary from 15 to 40 per square mile in Lane County according to 1982 estimates, depending on the type of habitat (ODFW files).

d. Assessment of impact

Riparian hardwood, grass-forb, open and closed conifer forest, and conifer-hardwood forest cover types comprised the majority of the 1,086 acres evaluated as ruffed grouse habitat prior to project construction (Table 8). The suitability of this habitat was rated 6 (above average) and was limited primarily by the lack of deciduous trees and habitat diversity. The relative value of the affected area for ruffed grouse prior to construction was 652 HU's (Table 8).

Construction of the project resulted in the immediate loss of 630 acres of ruffed grouse habitat, including 205 acres of riparian habitat (Table 8). Revegetation and successional changes from the postconstruction period to the recent period resulted in a yain of 463 acres of ruffed grouse habitat by 1979. However, there was still a net loss of 167 acres from preconstruction. Evaluation of recent (1979) conditions in the project area indicated a rating of 2 (poor) for the 919 acres of habitat available at that time (Table 8). Habitat was available in small, isolated pockets and lacked forage quality. Much disturbance occurred as a result of the highway and other roads. The 184 HU's calculated for the recent conditions represented a loss of 468 HU's from preconstruction conditions. The decline in HU's represents a loss in the potential of the project area to support ruffed grouse and other wildlife species with similar habitat requirements.

8. Waterfowl (Barrow's and common goldeneye, bufflehead, common merganser, harlequin)

a. Importance

Waterfowl were chosen as target species because of their high recreational value, their dependence on aquatic habitat, and tne impacts which occurred as a result of the project. Year-round habitat suitability was evaluated for 4 species which use the project area for breeding, wintering, or resting during migration. The habitat requirements of the 4 species (Barrow's and common goldeneye, bufflehead, comnon merganser) in this group encompass many of the basic requirements of other waterfowl species which may use the project area (Appendix A). In addition, the breeding habitat for harlequin ducks was evaluated separately because of their different habitat requirements.

Table 8. Ruffed grouse: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post.-construction	Loss or gain (+ or -) Preconstruction to recent
Temperate conifer forest, open	220	54	180	-166	-40
Temperate conifer forest, closed	254	24	63	-230	-191
Conifer-hardwood forest	186	105	84	-81	-102
Deciduous hardwood (oak)	0	4	5	+4	+5
Riparian shrub	13	6	2	-7	-11
Riparian hardwood	211	13	15	-198	-1%
Coniferous wetland*	0	5	5	+5	+5
Shrubland	19	105	264	+87	+246
Grass-forb	159	140	301	-19	+142
Agric., cropland	10	0	0	-10	-10
Agric., pasture	15	0	0	-15	-15
TOTAL ACRES	1,086	456	919	-630	-167
habitat Rating	6	1	2		
HABITAT UNITS	652	46	184	-606	-468

*Represents a portion of total acres present.

b. Habitat requirements

Swift streams and large lakes of the Cascade Mountains in Oregon provide either breeding or wintering habitat for several species of waterfowl. Among the species most likely to breed in the Hills Creek area are Barrow's goldeneye, common merganser, and harlequin. Barrow's goldeneyes are cavity nesters, preferring to nest within 100 feet of water but may nest as far as l/2 mile from the nearest water (Bellrose 1976, Terres 1980). Tree species frequently containing suitable cavities include cottonwood and Douglas-fir. Nest sites are usually located near relatively shallow lakes and ponds with extensive beds of submerged aquatic and marsh vegetation. Deep lakes with barren margins support few breeding birds (Bellrose 1976). Common mergansers typically nest in cavities also and prefer deciduous riparian habitat in later forest stages (USFS 1981b). Gabrielson and Jewett (1940) reported that common mergansers nested along swifter streams and shores of larger lakes throughout Oregon. Harlequins nest along rocky shores adjacent to turbulent mountain streams (Bellrose 1976), and will either nest on the ground or in holes in trees or cliffs (Gabrielson and Lincoln 1959). Brood habitat of harlequins consists of swift water with interspersed pools and riffles (Kuchel 1977).

Foods consumed by common mergansers include fish and fish eggs, aquatic invertebrates, frogs, newts, and some aquatic plants (Bellrose 1976, USFS 1981b). Common mergansers forage in clear water l-1/2 to 6 feet deep and eat a wide variety of fishes depending upon the species' availability. The diet of Barrow's goldeneyes consists of approximately 78% animal matter (Cottam 1939) and includes aquatic insects, crayfish, snails, sculpins, and salmon eggs (Munro 1939, Terres 1980). Plant foods consumed by goldeneyes are primarily seeds and vegetative parts of pondweeds, and algae (Bellrose 1976). Animal food comprises almost the entire diet of harlequins. During the summer they feed on stoneflies, water boatmen, and midge larvae (Gabrielson and Lincoln 1959).

Waterfowl species occurring at Hills Creek Reservoir during winter include common goldeneye, bufflehead, and common merganser. The diet of common goldeneyes consist of about 74% animal matter and includes crustaceans, aquatic insects, mollusks, and fish (Cottam 1939). Plant foods include seeds and tubers of pondweeds, and seeds of pond lilies andbulrushes. Bufflehead diets are similar to diets of common goldeneyes and are largely comprised of animal matter. During winter, snails and fish are important animal foods, while seeds of pondweeds and bulrushes are among the important plant foods (Erskine 1972).

C. History in the project area

Information was not available on waterfowl populations in the project area prior to construction. Harlequin ducks occur on fast-flowing streams in the general area around Hills Creek and probably used the Middle Fork Willamette River in the project area prior to construction. Common mergansers also may have used the project area before project construction.

d. Assessment of impact

Year-round habitat suitability was rated for 4 waterfowl species which potentially used the project area (Barrow's and common goldeneye, bufflehead, and common merganser). Harlequin ducks were rated separately because of their different habitat requirements. Harlequins winter along the coast, therefore, the value of the habitat at Hills Creek was assessed for breeding habitat only.

Habitat available to waterfowl (other than harlequins) prior to project construction consisted of 592 acres of conifer-hardwood forest, riparian shrub and hardwoods, sand/gravel/cobble, and river (Table 9). The suitability of this habitat for waterfowl use was rated 4 (below average). Mountain streams do not constitute quality waterfowl habitat, although most requirements of common mergansers were probably met. The relative value of preconstruction habitat was 237 HU's for waterfowl as a group (Table 9).

After construction of the Hills Creek Project, 2,811 acres of waterfowl habitat were available in the affected area. The increase in habitat was a result of the 2,710-acre reservoir, which serves primarily as a resting area for limited numbers of waterfowl during migration. River habitat (128 acres) and riparian habitat (205 acres) used for foraging and nesting by waterfowl were lost (Table 9). The suitability of this habitat was rated 1 (low), for a HU value of 281.

In 1979, habitat available to waterfowl in the project area consisted of 2,799 acres. A poor rating (2) was given, which resulted in a HU value of 560, or an increase of 323 HU's from preconstruction conditions. Small numbers (20-50) of waterfowl use the reservoir as a roosting area during fall and winter (L. Gangle, USFS, pers. commun.). The reservoir is not along a flyway and provides little foraging or nesting habitat because of its depth, steep shoreline, and fluctuating water levels. Hills Creek Reservoir is of "little value to waterfowl" (USACE and USFS 1963, 1568).

The suitability of the preconstruction habitat for harlequins, was rated 9 (high) resulting in 275 HU's available to harlequins (Table 10). Foraging, nesting, and roosting habitat conditions were near optimum, although higher gradient streams may be preferred by harlequins.

Harlequin ducks experienced adverse impacts due to the loss of nesting and brooa-rearing habitat associated with swift streams. Habitat available for harlequins was reduced to 54 acres after construction (Table 10). Lack of the fast-flowing stream and associated habitat and recent disturbance were contributing factors to the remaining habitat rating of 1 (low) and a relative habitat value of 5 HU's. This was a loss of 270 HU's from preconstruction conditions (Table 10).

Conditions were essentially the same in I979 as at postconstruction and the minimum suitability rating (1) was again given. The net loss of 269 HU's (Table 10) for harlequins in the affected area from preconstruction conditions to recent conditions is the equivalent of 269 acres of optimum harlequin habitat lost as a result of the project.

Table 9. Water-fowl: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover-Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Ost-construction	Loss or gain (+ or -) Preconstruction to recent
Conifer-hardwood forest	136	30	10	-106	-126
Riparian shrub	13	6	2	-7	-11
Riparian hardwood	211	13	15	-198	-1%
Coniferous wetland	0	17	20	+17	+20
Sand/gravel/cobble	75	6	4	-69	-71
River	157	29	38	-128	-119
Reservoir	0	2,710	2,710	+2,710	+2,710
TOTAL ACRES	592	2,811	2,799	+2,219	+2,207
Habitat Rating	4	1	2		
HABITAT UNITS	237	281	560	+44	+323

Table 10. Harlequin duck: Acres of habitat available and lost, habitat ratings, and habitat unite at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Conifer-hardwood forest	20	0	0	-20	-20
Riparian shrub	13	6	2	-7	-11
Riparina hardwood	40	13	15	-27	-25
Sand/gravel/cobble	75	6	4	-69	-71
River	157	29	38	-128	-119
TOTAL ACRES	305	54	59	-251	-246
Habitat Rating	9	1	1		
HABITAT UNITS	275	5	6	-270	-269

The decrease in HU's represents a loss in the potential of the project area to support harlequins and other wildlife species with similar habitat requirements or preferences.

9. Yellow warbler

a. Importance

The yellow warbler is on the USFWS (1982) list of sensitive bird species for Region One, which includes the project area. Although populations do not show significant changes in Oregon, they are declining throughout the region. The yellow warbler was chosen as a target species because of its use of riparian habitat, to represent other species with similar habitat requirements, and because of its sensitive status.

b. Habitat requirements

Preferred habitats of yellow warblers are wet areas with abundant shrubs or small deciduous trees (Hoffman 1927, Bent 1953). Nesting habitat is provided by deciduous shrubs and trees including willows, alders, and cottonwoods near streams. Coniferous areas and closed canopy forests are mostly avoided (Hoffman 1927, Schroeder 1982). Yellow warblers forage in deciduous shrubs and trees and primarily consume insects (Bent 1953, Schroeder 1982).

C. History in the project area

Information was not available on yellow warbler populations during the preconstruction period. The yellow warbler is considered a common species in Oregon (USFWS 1982). Breeding Bird Survey data collected throughout the region over 11 years do not indicate significant population changes for Oregon overall; however, population reductions have occurred in certain localities within the state (USFWS 1982).

d. Assessment of impact

Habitat available to yellow warblers prior to project construction consisted of 648 acres, about one-third of which was shrubland and riparian vegetation (Table 11). The riparian and shrubland cover types provided preferred habitat; however, the high elevation of the project area and the preponderance of conifer habitat precluded optimum use of the habitat overall. A suitability rating of 5 (average) was given for the preconstruction habitat conditions, resulting in 324 HU's available at that time.

After construction of the Hills Creek Project (1964), 304 acres of habitat were available, a loss of 344 acres. Much of the habitat lost was riparian hardwood and shrub. The suitability of the remaining habitat was rated 1 (low) because recent disturbance to the vegetation resulted in a relatively undeveloped shrub layer. Only 30 HU's were available at that time for yellow warblers, a loss of 294 HU's from preconstruction conditions.

Table 11. Yellow warbler: Act-es of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Temperate conifer forest, open	220	54	180	-166	-40
Conifer-hardwood forest	186	105	84	-81	-102
Deciduous hardwood (oak)	0	4	5	+4	+5
Riparian shrub	13	6	2	-7	-11
Riparian hardwood	211	13	15	-1%	-1%
Coniferous wetland	0	17	20	+17	+20
Shrubland	18	105	264	+87	+246
TOTAL ACRES	648	304	570	-344	-78
Habitat Rating	5	1	2		
HABITAT UNITS	324	xl	114	-2%	-210

By 1979, 570 acres of habitat were available. An increase in shrubland accounted for most of the habitat increase. The habitat was rated 2 (poor), resulting in 114 HU's available to yellow warblers, a loss of 210 HU's from preconstruction conditions. The decrease in HU's represents a loss in the potential of the project area to support yellow warblers and other wildlife species with similar habitat requirements.

10. American dipper

a. Importance

The American dipper was chosen as a target species because of its dependence on free-flowing stream habitat and because of impacts which occurred as a result of the project.

b. Habitat requirements

Dippers inhabit fast-flowing mountain streams throughout western North America. Characteristics of nest sites vary with local habitat conditions but usually include proximity to water, location above high water, inaccessibility to terrestrial predators, and location on a horizontal ledge or crevice for support (Sullivan 1973). Nests are often placed among rocks or behind waterfalls (Gabrielson and Jewett 1940). Escape cover is provided by logs, streamside vegetation, or the water in the stream (Sullivan 1965).

Dippers ordinarily forage in riffles and faster waters l/2-2 feet deep where many of the favored foods are concentrated (Bakus 1959). Aquatic insect larvae are a major food source; terrestrial and flying insects, amphibians, and fish are consumed less frequently (Bakus 1959, Thut 1970, Sullivan 1973).

C. History in the project area

Information was not available on populations of dippers during the preconstruction period. It may be assumed, however, that because river and stream habitats were more plentiful in the project area, dipper populations were larger prior to project construction than at present.

d. Assessment of impact

Prior to construction of the Hills Creek Project, 275 acres of available habitat existed for dippers in the project area (Table 12). Tne suitability of the habitat was rated 8 (high), for a value of 220 HU's, because of the contiguous stream and bank habitat available on the main river (8.5 miles) and tributaries, which provided the requirements for dipper foraging, cover, and reproduction. The preconstruction habitat value was 220 HU's.

Construction of the project resulted in a reduction of over 200 acres of available habitat from preconstruction conditions. Greatest losses occurred in the sand/gravel/cobble and river cover types (Table 12). The remaining habitat was assigned a suitability rating of 1 (low) at postconstruction (1964) and 3 (below average) in 1979. Rationale for the ratings included the limited amount of nesting and foraging habitat

Table 12. American dipper: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Conifer-hardwood forest	10	0	0	-10	-10
Riparian shrub	13	6	2	-7	-11
Riparian hardwood	20	2	2	-18	-18
Sand/gravel/cobble	75	6	4	-69	-71
River	157	29	38	-128	-119
Reservoir*	0	20	20	+20	+20
TOTAL ACRES	275	63	66	-212	-209
Habitat Rating	8	1	3		
HABITAT UNITS	220	6	20	-214	-200

*Represents a portion of total acres present.

available. Stream riffles and pools were limited except at the upper end of the reservoir and Packard Creek arm during drawdown. Post-construction suitability was rated lower because of the recent human activity in the area and habitat disturbance as a result of project construction. In 1964, 6 HU's were available to dippers. In 1979, 20 HU's were available, a loss of 200 HU's from preconstruction to recent conditions. The decrease in HU's represents a loss in the potential of the project area to support dippers and other species which use river and stream habitat.

11. Pileated woodpecker

a. Importance

The pileated woodpecker is a primary cavity excavator. Vacated woodpecker cavities are used by many birds and mammals for reproduction, roosting, shelter, or hibernation (Bull and Meslow 1977). The pileated woodpecker was chosen as a target species because of its preference for old-growth and mature forest habitat, to represent species which use those cover types, and because of impacts which occurred as a result of the project.

b. Habitat requirements

Pileated woodpeckers in western Oregon find optimum habitat for nesting and foraging in old-growth Douglas-fir forests (Meslow et al. 1981). Pileated woodpeckers also nest in true fir and deciduous trees (Bent 1964, Conner et al. 1975). Critical habitat components are large snags, large trees, diseased trees, dense forest stands, and high snag densities (Bull 1975). Pileated woodpeckers prefer to nest in 2-storied stands with a crown closure of approximately 70% and in trees or snags with a dbh greater than 20 inches (Bull 1975, Bull and Meslow 1977, Schroeder 1983).

Foraging habitats of pileated woodpeckers contain high densities of logs and snags, dense canopies, and tall shrub cover. Carpenter ants and their larvae, and other wood-boring insects are the primary food items of pileated woodpeckers (Bull 1975).

C. History in the project area

Information was not available on populations of pileated woodpeckers during the preconstruction period. It may be assumed, however, that because old-growth forests were more plentiful in the project area prior to project construction, pileated woodpecker populations were larger than at present.

d. Assessment of impact

The project area prior to construction contained an estimated 4,007 acres of habitat available to pileated woodpeckers. The combination of old-growth forests (3,136 acres), riparian hardwoods, and mature second-growth conifer forests made conditions nearly ideal and resulted in a habitat suitability rating of 9 (high) (Table 13).

Table 13. Pileated woodpecker: Acres of habitat availabel and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Temperate conifer forest, open	220	54	180	-166	-40
Temperate conifer forest, closed	254	24	63	-230	-191
Temperate conifer forest, old growth	3,136	442	442	-2,694	-2,694
Conifer-hardwood forest	186	105	84	-81	-102
Deciduous hardwood (oak)	0	4	5	+4	+5
Riparian hardwood	211	13	15	-1%	-1%
Coniferous wetland	0	17	20	+17	+20
TOTAL ACRES	4,007	659	809	-3,348	-3,198
Habitat Rating	9	4	5		
HABITAT UNITS	3,606	264	405	-3,342	-3,201

After construction of the Hills Creek Project (1964) 659 acres of habitat were available, a loss of 3,348 acres of high quality habitat. The remaining habitat was rated 4 (below average) because there were no large tracts of old-growth forest within the affected area, and because of recent habitat disturbance and human activity. The resulting loss was 3,342 HU's from preconstruction conditions.

The amount of habitat available to pileated woodpeckers in 1979 was 809 acres (Table 13). The suitability of this habitat was rated 5 (average). Foraging habitat quality was considered average because of the limited amount of down logs and snags available. The remaining habitat contained few potential nest sites. The lack of large old-growth forest and the potential for human disturbance prevented assessment of a higher rating. The 405 HU's available to pileated woodpeckers in 1979 represent a loss of 3,201 HU's from the 3,606 HU's present prior to construction. The decline in HU's represents a loss in the potential of the project area to support pileated woodpeckers and other wildlife species with similar habitat requirements.

12. Northern spotted owl

a. Importance

The northern spotted owl is currently classified by ODFW as threatened in Oregon. Populations in Oregon appear to be declining as old-growth conifer forests are gradually eliminated (Forsman et al. 1985). The spotted owl is frequently used as an indicator species in the Pacific Northwest because it is sensitive to land use actions affecting old-growth forests. The spotted owl was chosen as a target species because of its threatened status, management emphasis within Oregon, because of its dependence on old-growth froests, and to represent the group of species which find optimum habitat in old-growth forests.

b. Habitat requirements

Recent studies in western Oregon identified old-growth forests as required habitat for spotted owls (Forsman et al. 1977, 1984). Ninety-eight percent of the pairs located by Forsman et al. (1984) were found in unlogged old-growth forests (>200 years old) or in mixed forests of old-growth and mature timber. Nesting habitat is provided by multi-layered (uneven-aged) old-growth forests. Most spotted owl nests in western Oregon are located in cavities in old-growth conifers; others occur on platforms in mature or old-growth conifers (Forsman et al. 1984). Nests are typically found within 1,000 feet of a spring or small stream. Spotted owls also prefer old-growth forests for roosting (more than 90% of the time), because these forests provide protection under most weather conditions (Forsman et al. 1984).

Radio-tagged owls on the west slope of the Cascade Mountains show a strong preference for foraging in unlogged old-growth forests (Forsman et al. 1984). Second-growth forests older than 25-35 years of age provide marginal foraging habitat. The diet of spotted owls varies seasonally, with a variety of mammals, birds, and insects consumed. Mammals comprise 92% of all prey taken (Forsman et al. 1984). During

fall and winter, the primary prey of spotted owls in forests of Douglas-fir and western hemlock are northern flying squirrels. During spring and summer, snowshoe hares, shrews, pocket gophers red tree voles, western red-backed voles, small birds, and insects'become increasingly common in the diet (Forsman et al. 1984).

C. History in the project area

Spotted owls were historically thought to be uncommon or rare throughout their range because they inhabit dense forests and were seldom observed (Forsman et al. 1985). Prior to the late 1960's, techniques did not exist which allowed the collection of reliable population data (Forsman et al. 1984). It may be assumed, however, that historically the acreage of old-growth forest was greater and consequently spotted owl populations were larger than they are now. Two spotted owl management areas (SOMA's) are located within 1 mile of the east side of the reservoir and 1 SOMA is located west of the reservoir.

d. Assessment of impact

Habitat available to spotted owls in the affected area prior to project construction consisted of 3,796 acres, 3,136 acres of which were old-growth conifer forest (Table 14). The suitability of the habitat for spotted owls was assessed a value of 8 (high), yielding 3,037 HU's. The contiguous acres of old-growth forest provided food, cover, and breeding requirements.

Construction of the Hills Creek Project resulted in the loss of 2,694 acres of old-growth forest (Table 14). The remaining fragmented habitat could not support spotted owls; however, spotted owls from adjacent old-growth areas may use portions of the remaining habitat for foraging. The suitability of the remaining habitat was rated 1 (low) and valued at 63 HU's at postconstruction and 60 HU's more recently (Table 14). Construction of the Hills Creek Project resulted in the loss of over 2,970 HU's. The decline in HU's represents a loss in the potential of the project area to support spotted owls and other wildlife species with similar habitat preferences requirements.

In addition to the loss of habitat, the presence of Hills Creek Reservoir may inhibit movement of spotted owls in the area. Forsman et al. (1984) reported that owls with home ranges adjacent to Blue River Reservoir rarely crossed the reservoir except at the upper end where it is less than 164 yards wide. The reservoir may prevent owls in the area fron extending their home ranges, which could be necessary for their survival if adjacent old-growth forests are logged and no longer available as habitat.

13. Bald eagle

a. Importance

The bald eagle is classified by ODFW and USFWS as threatened in Oregon. The Pacific States Bald Eagle Recovery Team (1982) set recovery goals for bald eagle populations in Oregon and identified Hills Creek

Table 14. Spotted owl: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre- to Post-construction	Loss or gain (+ or -) Preconstruction to recent
Temeprate conifer forest, open	220	54	54	-166	-166
Temperate conifer forest, closed	254	24	24	-230	-230
Temperate conifer forest, old growth	3,136	442	442	-2,694	-2,694
Conifer-hardwood forest.	186	105	84	-81	-102
TOTAL ACRES	3,796	625	604	-3,171	-3,192
Habitat Rating	8	1	1		
HABITAT UNITS	3,037	63	60	-2,974	-2,977

Reservoir as a "key area" with 1 known bald eagle territory, 3 potential territories, and a wintering population of 10 birds. Potential nesting areas were determined by historical nest records, occasional sightings of adult eagles, and/or presence of old-growth forests within 1 mile of a water body possessing a good supply of fish and/or waterfowl. The bald eagle was chosen as a target species because of its threatened status, management emphasis within Oregon and specifically at Hills Creek Reservoir, and because bald eagles may have benefited from the construction of the Hills Creek Project.

b. Habitat requirements

Bald eagles find optimum nesting and roosting habitat in old-growth forests (Meslow et al. 1981). In western Oregon, Douglas-fir is the most frequently used tree species for nesting (Anthony et al. 1982). Tree structure and uneven-aged forest stands appear to be more important, however, than tree species in the selection of nest trees. Nest trees are typically the largest tree in the stand and are usually located within 1 mile of large bodies of water (Anthony et al. 1982). Winter roosting sites are characterized by a protected microclimate, stout perches high above the ground, a clear view of surrounding terrain, and freedom from human activity (Hansen et al. in Stalmaster et al. 1985). Bald eagles use both deciduous roosts in riparian habitat and coniferous roosts for protection from adverse weather (Stalmaster and Newman 1979). Bald eagles use mature or old-growth roost trees that are larger than the average size of surrounding trees (Hansen et al. 1980, Keister 1981, Anthony et al. 1982).

Bald eagles forage in open areas, usually associated with rivers, lakes, or coastal shorelines (Stalmaster et al. 1985). The Pacific States Bald Eagle Recovery Team (1982) stated that food supply is probably the most critical component of bald eagle wintering habitat in the Pacific Region. The most common foods of eagles in this region include fish, waterfowl, and carrion. Anadromous fish, trout, whitefish, squawfish, carp, suckers, and tui chubs are consumed by eagles (Pacific States Bald Eagle Recovery Team 1982). Waterfowl are an important food item for eagles in the Klamath Basin (Keister 1981) and at some reservoirs on the Columbia River (Fielder 1982). Studies in Washington (Servheen 1975, Stalmaster 1976) identified mammalian carrion as an important alternate food source. Because the young are less tolerant of food deprivation than adults, a constant food supply is most important during the nesting season (Stalmaster et al. 1985).

Perching sites are another important feature of bald eagle habitat. Proximity to food is the primary factor governing selection of perching sites (Steenhof et al. 1980). Preferred perching sites are on the edge of stands and include the tallest trees with strong, lateral branches nigh in the crown (Stalmaster et al. 1985). Perches may also be used as "sentry" sites by breeding adults for defending the nest. Snags are preferred perching sites in winter, and when near the nest tree, are preferred perching locations during the nesting season (Stalmaster and Newman 1979, Forbis et al. in Stalmaster et al. 1985).

C. History in the project area

Information was not available on the status of bald eagle populations in the project area prior to construction. One adult and 5 immature eagles were observed in the Hills Creek area during the 1982 mid-winter bald eagle survey. Three adult eagles were observed in 1983. The area currently supports an estimated wintering population of 10 bald eagles.

d. Assessment of impact

Prior to project construction the affected area contained 3,820 acres of bald eagle habitat (Table 15). Most of this acreage was old-growth forest, which provided potential nesting and roosting sites. The tributaries and 8.5 miles of river provided a limited prey base. Anadromous fish were not present because of Lookout Point and Dexter dams. The suitability of this habitat was rated 4 (below average) for bald eagles, indicating 1,528 HU's were available prior to project construction.

Construction of the Hills Creek Project resulted in the loss of 3,054 acres of terrestrial habitat used by bald eagles for nesting and perching. The project created an additional 2,591 acres of aquatic habitat used by bald eagles for foraging. The fish prey base was adequate, but perch sites were lacking. Potential nesting sites were available. Increased human access resulting from the project may cause disturbance to feeding, nesting, or roosting bald eagles. The suitability of the habitat directly after completion of the project (1964) was rated 5 (average) and in 1979 was rated 6 (above average) because of an increased prey base. By 1979, 3,357 acres of bald eagle habitat were present in the affected area and the relative value of that habitat was 2,014 HU's (Table 15). From preconstruction conditions to 1979, 486 HU's were gained as a result of the project.

14. Osprey

a. Importance

The osprey is included on the USFWS (1982) list of national species of special emphasis and was chosen as a target species because of management interest within Oregon, and because this species may have benefited from the construction of the Hills Creek Project.

b. Habitat requirements

Ospreys inhabit mid to late-stage forests near lakes or large rivers. Nests are usually located within 1 mile of water (Koplin 1971). Nests are most commonly on the top of partially or completely dead trees ranging in height from 50-250 feet (French and Koplin 1972). Lind (1976) reported an average height of 120 feet and average dbh of 43 inches for osprey nest trees adjacent to Crane Prairie Reservoir, Oregon. In addition to the nest tree, at least one other large tree located within 150 yards of the nest is regularly used by the nesting pair and fledglings for sunning, protection from wind, and as a "lookout" perch and feeding post (Lind 1976, Zarn undated). Ospreys require open and clear water for foraging. Their diet is almost exclusively fish, generally 6-12 inches in length (Lind 1976).

Table 15. Bald eagle: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	Post-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre to Post-construction	Loss or gain (+ or -) Precosntruction to recent
Temperate conifer forest, open	50	40	40	-10	-10
Temperate conifer forest, closed	5	24	24	+19	+19
Temperate conifer forest, old growth	3,136	442	442	-2,694	-2,694
Conifer-hardwood forest	186	105	84	-81	-102
Riparian hardwood	211	13	15	-198	-1%
Sand/gravel/cobble	75	6	4	-69	-71
River	157	29	38	-128	-119
Reservoir	0	2,710	2,710	+2,710	+2,710
TOTAL ACRES	3,820	3,369	3,357	-451	-463
Habitat Rating	4	5	6		
HABITAT UNITS	1,528	1,685	2,014	+157	+486

C. History in the project area

The only information available on osprey populations during the preconstruction period was a study by Gullion (1951) in which the osprey was reported to be an unocmmon summer resident of Lane County during the period 1938-48. In 1976, Henny et al. (1978) identified 2 nesting pairs at Hills Creek Reservoir. There are currently 4 osprey nests near Hills Creek, 3 of which are active (B. Ferry, ODFW, pers. commun.).

d. Assessment of impact

Osprey habitat within the affected area consisted of old-growth and the larger open and closed conifer forest stands, conifer-hardwood forest, riparian hardwood, sand/gravel/cobble, and river cover types. Prior to construction of the project, 3,820 acres of habitat were available to ospreys within the affected area (Table 16). The suitability of the habitat for ospreys during the breeding season was assessed as 6 (above average) by the interagency evaluation group. Thus, 2,292 HU's were available to ospreys prior to construction. Nesting requirements were met and although anadromous smolts were not available because of Lookout Point and Dexter dams, resident fish probably provided an adequate prey base.

Construction of the Hills Creek Project resulted in a loss of 3,074 acres of terrestrial habitat available to ospreys for nesting and perching. The project created an additional 2,591 acres of aquatic habitat which could be used by ospreys for foraging. Hills Creek Reservoir probably benefited osprey populations in the project area by creating this additional foraging habitat, although foraging conditions were less than optimum because of turbidity and lack of perch sites near water. The project has resulted in increased human access and disturbance which may adversely affect nesting success. The suitability of the habitat directly after completion of the project (1964) was rated 6 and in 1979 was rated 7 (above average) because of an increased prey base. By 1979, 3,337 acres of habitat were available to ospreys. The relative value of the habitat was 2,336 HU's (Table 16). This would indicate that 44 HU's were gained for ospreys as a result of the project.

V. SUMMARY

The Hills Creek Project inundated, extensively altered, or affected 4,662 acres of land and river in the Middle Fork Willamette River drainage. Impacts to wildlife centered around the loss of 2,694 acres of old-growth forest and 207 acres of riparian habitat. Seventeen cover types were identified within the area directly affected by construction and operation of the hydroelectric-related components of the project. Acreages of each cover type were calculated for 3 time periods: prior to project construction (1944), directly after construction (1964), and more recently (1979) (Table 1).

Project impacts were evaluated for 15 wildlife species or species groups selected from the list of species likely to occur in the project area (Appendix A). A habitat-based evaluation system was used to assess the

Table 16. Osprey: Acres of habitat available and lost, habitat ratings, and habitat units at Hills Creek Project.

Cover Type	Pre-construction (1944)	POst-construction (1964)	Recent (1979)	Loss or gain (+ or -) Pre to post-construction	Loss or gain (+ or -) Preconstruction to recent
Temeprate conifer forest, open	50	20	20	-30	-30
Temperate conifer forest, closed	5	24	24	+19	+19
Temperate conifer forest, old growth	3,136	442	442	-2,694	-2,694
Conifer-hardwood forest	186	105	84	-81	-102
Riparian hardwood	211	13	15	-198	-1%
Sand/gravel/cobble	75	6	4	-69	-71
River	157	29	38	-128	-119
Reservoir	0	2,710	2,710	+2,710	+2,710
TOTAL ACRES	3,820	3,349	3,337	-471	-483
Habitat Rating	6	6	7		
HABITAT UNITS	2,292	2,009	2,336	-283	+44

suitability of preconstruction, postconstruction, and recent habitat for the target species or species groups. Losses or gains to these species as a result of the hydroelectric-related components of the Hills Creek Project were calculated and are summarized in Table 17. Impacts resulting from the Hills Creek Project included the loss of winter range for Roosevelt elk, and the loss of year-round habitat for black-tailed deer, black bear, cougar, river otter, beaver, ruffed grouse, spotted owl and other nongame species. Bald eagle and osprey were benefitted by an increase in foraging habitat.

Impacts to target species were measured by determining the difference between habitat units (HU's) prior to construction and after construction. HU's are a measure of the quantity (habitat area) and quality (suitability) of available habitat. One HU is equivalent to 1 acre of optimum habitat. In most cases the losses in HU's were greater irrrnediately following project construction than when measured 16 years after completion of the project because of natural revegetation in the portion of affected area which was not inundated. These differences are discussed in the target species sections of the report. To simplify the summary table, however, only losses or gains which occurred from preconstruction to the more recent condition were addressed. The habitat units lost or gained (Table 17) represent the change in the potential of the habitat to support the given species at one point in time. That potential, however, was lost over the entire life of the project, a point which should be remembered when planning mitigation. It should also be noted that HU's lost or gained are not totaled among species. Each species was evaluated separately. When mitigation, enhancement or protection measures are conducted, a single activity may improve the habitat for more than one species and would be credited for doing so. If it is not possible to mitigate in-kind (for the same species which experienced losses), out-of-kind mitigation, and hence trade-off mitigation may have to be negotiated. Benefits to bald eagles and ospreys, for example, may be credited against losses to other species during the process of establishing trade-off mitigation levels.

In most cases it was not practical or possible to estimate the number of animals lost or gained as a result of the project. Site specific wildlife population estimates prior to construction were not available. Density estimates were available for the Middle Fork Willamette River drainage in 1948 (OSGC) for deer and grouse, but these figures were generalized and not representative of the actual losses which occurred at the Hills Creek Project. For example, density estimates for deer do not reflect the level of use the project area might have received during severe winter conditions and, thus, its long term importance to the deer population in the drainage. The Hills Creek site was considered by the evaluation team to be above average ruffed grouse habitat, which may have supported a higher density of grouse than indicated by the average estimate for the drainage. The technique used in 1948 to estimate deer and grouse densities was not documented. The estimates were made 8 years prior to initiation of project construction. Possibly the factor which most complicates the attempt to estimate the number of animals lost or gained as a result of the Hills Creek Project is the considerable change in conditions for wildlife in the Willamette Basin caused by timber harvesting and increased human development. The nubmer

Table 17. Summary of impacts (preconstruction to recent) to target species as a result of the hydroelectric-related components of the Hills Creek Project, Middle Fork Willamette River, Oregon.

Species (group)	Acres of habitat lost or gained[a]	Habitat Units lost or gained[ab]	Estimated No, animals lost or gained[b]	Impacts
BIG GAME				
Roosevelt elk	-2,912	-3,203	Unknown	Loss of winter habitat. Migration and movement inhibited or blocked. Increased disturbance.
Black-tailed deer	-2,912	-2,912	Unknown	Loss of winter/summer habitat. Migration and movement inhibited or blocked. Increased disturbance.
Black bear	-3,011	-2,958	Unknown	Loss of year-round habitat. Movement inhibited. Increased disturbance,
Cougar	-2,826	-2,381	Unknown	Loss of habitat. Loss of habitat for prey species. Increased disturance.
FURBEARERS				
River otter	-387	-384	-1 to 7c on Middle Fork only, does not include tributary streams	Loss of year-round habitat. Movement inhibited or blocked,
Beaver	-477	-326	-60 to 85c on Middle Fork only, does not include tributary streams	Loss of year-round habitat. Movement inhibited or blocked.

Table 17 (contd.). Summary of impacts (preconstruction to recent) to target species as a result of the hydroelectric-related components of the Hills Creek Project, Middle Fork Willamette River, Oregon.

Species (group)	Acres of habitat lost or gained[a]	Habitat Units lost or gained[ab]	Estimated No. animals lost or gained[b]	Impacts
UPLAND GAME				
Ruffed grouse	-167	-468	-1 to 10[d]	Loss of year-round habitat.
WATERFOWL				
Harlequin duck	-246	-269	Unknown	Loss of breeding and foraging habitat.
Barrow's goldeneye, common goldeneye, bufflehead, and common merganser	+2,207	+323	Unknown	Loss of breeding habitat. Additional migratory resting and foraging habitat provided.
NONGAME SPECIES				
Yellow warbler	-78	-210	Unknown	Loss of breeding and migratory habitat.
American dipper	-209	-200	Unknown	Loss of year-round habitat.
Pileated woodpecker	-3,198	-3,201	Unknown	Loss of year-round habitat, Increased disturbance,
Spotted owl	-3,192	-7,977	Unknown	Loss of year-round habitat. Movement probably inhibited. Increased disturbance.
Bald eagle	-463	+486	Unknown	Loss of nesting and roosting habitat. Increased disturbance, Foraging habitat probably increased.

Table 17 (contd,). Summary of impacts (preconstruction to recent) to target species as a result of the hydroelectric-related components of the Hills Creek Project, Middle Fork Willamette River, Oregon.

Species (group)	Acres of habitat lost or gained[a]	Habitat Units lost or gained[ab]	Estimated No. animals lost or gained[b]	Impacts
Osprey	-483	+44	Unknown	Loss of nesting and perching habitat. Increased disturbance. Foraging habitat probably increased.

a From preconstruction (1944) to recent (1979).

b This number represents the losses or gains at one point in time, not over the life of the project.

c Based on ODFW 1982 density estimates for Lane County (see target species section of report).

d Based on OSGC 1948 and ODFW 1982 estimates (see target species section of report).

of animals using the site at a given time does not adequately reflect the level of project impact because population fluctuations have occurred as a result of other factors. The potential of the affected area to support wildlife was altered as a result of the project and that change can be quantified in terms of HU's.

Impacts considered in this report were limited to effects of construction and operation of the hydroelectric-related components of the Hills Creek Project unless otherwise stated. These impacts would have occurred even if the project was not used for flood control or other nonhydroelectric purposes. Quantitative impacts considered were limited to the area directly affected by the project. Cumulative or system-wide impacts were not quantitatively assessed. Losses of wildlife and wildlife habitat resulting from increased human development as a result of the Willamette Reservoir System were not addressed. Indirect impacts such as degradation of habitat adjacent to the project site as a result of increased human development and recreational use were not measured.

No documentation was found nor were resource agency personnel aware of any mitigation, enhancement, or protection measures implemented by USACE at the Hills Creek Project to offset impacts to wildlife resulting from construction or operation of the project (Bedrossian et al. 1984). During consultation/coordination meetings, USACE representatives requested the Hills Creek loss statement acknowledge USACE's implementation of mitigation measures for anadromous fish.

VI. REFERENCES CITED

Allen, A. W. 1982. Habitat suitability index models: beaver. U.S. Dep. Inter., Fish and Wildl. Serv. FWS/OBS-82/10.30. 20 pp.

Aney, W. W. 1967. Wildlife of the Willamette Basin, present status. Basins Invest. Sect., Oreg. State Game Comm., Portland. 139 pp.

Anthony, R. G., R. L. Knight, G. T. Allen, R. B. McClelland, and J. I. Hodges. 1982. Habitat use by nesting and roosting bald eagles in the Pacific Northwest. Trans. North Am. Wildl. and Nat. Resour. Conf. 47:332-342.

Bakus, G. J. 1959. Observations on the life history of the dipper in Montana. Auk 76: 190-207.

Bedrossian, K. L., R. D. Carleson, J. H. Noyes, and M. S. Potter. 1984. Status review of wildlife mitigation at Columbia Basin hydroelectric projects, Oregon facilities. Oreg. Dep. Fish and Wildl., Environ. Manage. Sect. and U.S. Dep. Energy, Bonneville Power Adm., Div. Fish and Wildl. Paging various.

Beebe, B. F., and J. R. Johnson. 1965. American bears. David McKay Co., Inc., New York. 182 pp.

Bellrose, F. C. 1976. Ducks, geese, and swans of North America. Stackpole Books, Harrisburg, Pa. 540 pp.

Bent, A. C. 1953. Life histories of North American wood warblers. U.S. Nat., Mus. Bull. 203. 734 pp.

_____. 1964. Life histories of North American woodpeckers. Dover Publ., Inc., New York. 334 pp.

Brewer, L. W. 1980. The ruffed grouse in western Washington. Biol. Bull. No. 16, Wash. State Dep. Game, Olympia. 101pp.

Brown, E. R. 1961. The black-tailed deer of western Washington. Biol. Bull No. 13, Wash. State Dep. Game, Olympia. 124 pp.

Bull, E. L. 1975. Habitat utilization of the pileated woodpecker, Blue Mountains, Oregon. M. S. Thesis, Oreg. State Univ., Corvallis. 58 pp.

_____, and E. C. Meslow. 1977. Habitat requirements of the pileated woodpecker in northeastern Oregon. J. For. 75(6):335-337.

Bump, G., R. W. Darrow, F. D. Edminster, and W. F. Crissey. 1947. The ruffed grouse: life history, propagation, management. New York State Conserv. Dep., Albany. 915 pp.

Chambers, R. E., and W. M. Sharp. 1958. Movement and dispersal within a population of ruffed grouse. J. Wildl. Manage. 22:231-239.

Cleary, B. 1976. Food for elk. Oreg. Wildl. 31(12):6-7.

Conner, R. N., R. G. Hooper, H. S. Crawford, and H. S. Mosby. 1975. Woodpecker nesting habitat in cut and uncut woodlands in Virginia. J. Wildl. Manage. 39:144-150.

Cottam, C. 1939. Food habits of North American diving ducks. U.S. Dep. Agric., Tech. Bull. 643. 140 pp.

Deems, E. F., Jr., and D. Pursley. 1983. North American furbearers: a contemporary reference. Int. Assoc. Fish and Wildl. Agencies. 223 pp.

Durbin, K. 1979. The forest drummer, a look at the ruffed grouse in Oregon. Oreg. Wildl. 34(9):3-7.

Ebert, P. W. 1977. Report from Oregon. Pages 88-90 in D. Burk, ed. The black bear in modern North America. Proc. Workshop on the Manage. Biol. of North Am. Black Bear.

_____. 1979. State and provincial status reports, Oregon. Pages 73-76 in A. LeCount, ed. First Western Black Bear Workshop. Bear Biol. Assoc.

Edminster, F. C. 1947. The ruffed grouse: its life story, ecology and management. The Macmillan Co., New York 383 pp.

Erskine, A. J. 1972. Buffleheads. Can. Wildl. Serv. Monogr. Ser 4. 240 pp.

Fielder, P. C. 1982. Food habits of bald eagles along the mid-Columbia River, Washington. Murrelet 63:46-50.

Forsman, E. D., K. M. Horn, and G. W. Mires. 1985. Northern spotted owls Pages 259-267 in E. R. Brown, ed. Management of wildlife and fish habitats in forests of western Oregon and Washington. ?art 1. U.S. Dep. Agric., For. Serv., Pacific Northwest Reg.

, E. C. Meslow, and M. J. Strub. 1977. Spotted owl abundance in young versus old-growth forests. Oregon Wildl. Soc. Bull. 5(2):43-47.

_____, _____, and H. M. Wight. 1584. Distribution and biology of the spotted owl in Oregon. Wildl. Monogr. 87. 64pp.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. U.S. Pep. Agric., For. Serv., Gen. Tech. Pep. PNW-8. 417 pp.

French, J. M., and J. R. Koplin. 1972. Distribution, abundance, and breeding status of ospreys in northwestern California. Pages 223-240 in J. C. Ogden, ed. Trans. North Am. Osprey Res. Conf., Coll. of William and Mary, Williamsburg, Va. 258 pp.

Gabrielson, I. N., and S. G. Jewett. 1940. Birds of Oregon. Republ. in 1970 as Birds of the Pacific Northwest, Dover Publ., Inc., New York. 650 pp.

and F. C. Lincoln. 1959. Birds of Alaska. The Stackpole Co., -Harrisburg, Pa., and Wildl. Manage. Inst., Wash., D. C. 683 pp.

Gullion, G. W. 1951. Birds of the southern Willamette Valley, Oregon. Condor 53:129-149.

_____ 1966. A viewpoint concerning the significance of studies of game bird food habits. Condor 68:372-376.

Hall, F. C., L. W. Brewer, J. F. Franklin, and R. L. Werner. 1985. Plant communities and stand conditions. Pages 17-31 and append. 5 and 6 in E. R. Brown, ed. Management of wildlife and fish habitats in forests of western Oregon and Washington. Part 1 and 2. U.S. Dep. Agric., For. Serv., Pacific Northwest Reg.

Hanley, T. A. 1983. Black-tailed deer, elk, and forest edge in a western Cascades watershed. J. Wildl. Manage. 47(1):237-242.

Hansen, A. J., M. V. Stalmaster, and J. R. Newman. 1980. Habitat characteristics, function, and destruction of bald eagle communal roosts in western Washington. Pages 221-229 in Knight et al., eds. Proc. Washington Bald Eagle Symposium, The Nature Conservancy, Seattle, Wash.

Harcombe, D. W. 1976. Oregon cougar study. Oreg. Dep. Fish and Wildl., Portland. 62 pp.

Harper, J. A. 1966. Ecological study of Roosevelt elk. Res. Rep 1, Oreg. State Game Comm., Portland. 29 pp.

_____. 1971. Ecology of Roosevelt elk. Oreg. State Game Comm., Portland. 44 pp.

Henny, C. J., J. A. Collins, and W. J. Deibert. 1978. Osprey distribution, abundance, and status in western North America: II. The Oregon population. Murrelet 59:14-25.

Herrero, S. M. 1977. Black bears: the grizzly's replacement? Pages 179-195 in D. Burk, ed. The black bear in modern North America. Proc. Workshop on the Manage. Biology of North Am. Black Bear. 299 pp.

Hines, W. W. undated. Aspects of Oregon black-tailed deer management, prepared for intradepartmental consideration and use. Oreg. State Game Comm. Unpubl. rep. Paging various.

Hoffman, R. 1927. Birds of the Pacific states. The Riverside Press, Cambridge, Mass. 353 pp.

Hornocker, M. G. 1970. An analysis of mountain lion predation upon mule deer and elk in the Idaho Primitive Area. Wildl. Monogr. No. 21. 39 pp.

Ingles, L. G. 1965. Mammals of the Pacific states. Stanford Univ. Press, Stanford, Calif. 506 pp.

Ingram, R. 1984. 1983 Big game harvest. Oreg. Wildl. 39(5):3-10.

Johnsgard, P. A. 1973. Grouse and quails of North America. Univ. Nebr. Press, Lincoln. 553 pp.

Joint Federal-State-Private Conservation Organization Committee. 1974. Ecological planning and evaluation procedures. U.S. Dep. Inter., Fish and Wildl. Serv., Wash., D.C. 269 pp.

Jonkel, C. 1978. Black, brown (grizzly), and polar bears. Pages 227-248 in J. L. Schmidt and D. L. Gilbert, eds. Big game of North America, ecology and management. Stackpole Books, Harrisburg, Pa.

Kebbe, C. E. 1960. Oregon's beaver story. Oreg. State Game Comm. Bull. 15(2):3-6.

Keister, G. P., Jr. 1981. Characteristics of winter roosts and populations of bald eagles in the Klamath Basin. M. S. Thesis, Oreg. State Univ., Corvallis. 82 pp.

Koplin, J. R., ed. 1971. Osprey workshop: summary of research findings and management recommendations. Trans. Calif.-Nev. Sect. The Wildl. Soc.:114-122.

Kuchel, C. R. 1977. Some aspects of the behavior and ecology of harlequin ducks breeding in Glacier National Park, Montana. M.S. Thesis, Univ. Mont., Missoula. 163 pp.

LaDue, H. J. 1935. Guide for trapping and care of raw furs. St. Peter, Mn. 67 pp.

Lawrence, W., chairman. 1977. Working group report, Pacific working group. Pages 196-217 in D. Burk, ed. The black bear in modern North America. Proc. Workshop on the Manage. Biol. of North Am. Black Bear.

Liers, E. E. 1951. Notes on the river otter (Lutra canadensis). J. Mammal. 32(1):1-9.

Lind, G. S. 1976. Production, nest site selection, and food habits of ospreys on Deschutes National Forest, Oregon. M.S. Thesis, Oreg. State Univ., Corvallis. 53 pp.

Lindzey, F. G. 1976. Black bear population ecology. PhD Diss., Dreg. State Univ., Corvallis. 105 pp.

, and E. C. Meslow. 1977. Home range and habitat use by black bears in southwestern Washington. J. Wildl. Manage. 41(3):413-425.

Lindzey, J. S. 1943. A study of Columbian black-tailed deer Odocoileus hemionus columbianus (Richardson), and its habitat in Oregon. M. S. Thesis, Oreg. State Coll., Corvallis. 67 pp.

Mace, R. U. 1953. Oregon's big game resources. Oreg. State Game Comm., Portland. 34 pp.

_____. 1956. Oregon's elk. Wildl. Bull. No. 4. Oreg. State Game Comm., Portland. 33 pp.

1971. Trapping and transplanting Roosevelt elk to control damage and establish new populations. Proc. Ann. Conf. West Assoc. State Game and Fish Comm. 51:464-470.

1979. Oregon's furbearing mammals. Wildl. Bull No. 3. Oreg. Dep. Fish and Wildl., Portland. 82 pp.

Marshall, D. B. 1984. Oregon nongame wildlife management plan, review draft. Dreg. Dep. Fish and Wildl., Portland. Paging various.

Maser, C., B. R. Mate, J. F. Franklin, and C. T. Dyrness. 1981. Natural history of Oregon coast mammals. U.S. Dep. Agric., For. Serv., Gen. Tech. Rep. PNW-13. Pacific Northwest For. and Range Exp. Station, Portland, Oreg. 496 pp.

Masson W. V and R. U. Mace. 1574. Upland game birds. Wildl. Bull. No. 5, Oreg. Wildl. Comm., Portland. 44pp.

Maxson, S. J. 1978. Spring home range and habitat use by female ruffed grouse. J. Wildl. Manage. 42(1):61-71.

McCollum, M. T. 1973. Habitat utilization and movements of black bears in southwest Oregon. M. S. Thesis, Calif. State Univ., Humboldt. 67 pp.

Melquist, W. E.. and M. G. Hornocker. 1983. Ecology of river otters in west central Idaho. Wildl. Monog. No. 83. 60-pp.

Meslow, E. C., C. Maser, and J. Verner. 1981. Old-growth forests as wildlife habitat. Trans. North Am. Wildl. and Nat. Resour. Conf. 46:329-335.

Miller, F. L. 1966. Distribution patterns of black-tailed deer (Odocoileus hemionus columbianus) in relation to environment. M. S. Thesis, Oreg. State Univ., Corvallis. 90 pp.

. 1968. Observed use of forage and plant communities by black-tailed deer. J. Wildl. Manage. 32:142-148.

Munro, J. A. 1939. Studies of waterfowl in British Columbia: Barrow's goldeneye, American goldeneye. Trans. Royal Can. Inst. 22(48):259-318.

Oregon State Game Commission. 1933. Elk of Oregon. Bull. No 2. Oreg. State Game Comm., Portland. 8 pp.

_____ and Fish Commission. of Oregon. 1948. Fish and wildlife problems arising from the Willamette Valley Project. Portland, Oreg. 99 PP.

Pacific States Bald Eagle Recovery Team. 1982. Pacific states bald eagle recovery plan. Tech. review draft. Unpubl. rep., U.S. Dep. Inter., Fish and Wildl. Serv., Portland, Oreg. 73 pp + append.

Rue, L. L., III. 1981. Furbearing animals of North America. Crown Publishers, Inc., New York 343 pp.

Russell, K. R. 1978. Mountain lion. Pages 207-225 in J. L. Schmidt and D. L. Gilbert, eds. Big game of North America, ecology and management. Stackpole Books, Harrisburg, Pa. 494 pp.

Scheffer, V. B. 1941. Management studies of transplanted beavers in the Pacific Northwest. Trans. North Am. Wildl. Conf. 6:320-325.

Schroeder, R. L. 1982. Habitat suitability index models: yellow warbler. U.S. Dep. Inter., Fish and Wildl. Serv. GWS/OBS - 82/10.27. 8 pp.

_____. 1983. Habitat suitability index models: pileated woodpecker. U.S. Dep. Inter., Fish and Wildl. Serv. FWS/OBS-82/10.39 16 pp.

Servheen, C. W. 1975. Ecology of the wintering bald eagles on the Skagit River, Washington. M. S. Thesis, Univ. Wash., Seattle. 96 PP.

Seton, E. T. 1953. Lives of game animals. Charles T. Branford Co., Boston, Mass. np.

Sharp, W. M. 1963. The effects of habiitat manipulation and forest succession on ruffed grouse. J. Wildl. Manage. 27(4):664-671.

Shay, R. 1978. Oregon's beaver. Oreg. Wildl. 33(2):3-5.

Sheldon, W. G., and W. G. Toll. 1964. Feeding habits of the river otter in a reservoir in central Massachusetts. J. Mammal. 45(3):449-455.

Stalmaster, M. V. 1976. Winter ecology and effects of human activity on bald eagles in the Noosack River Valley, Washington. M. s. Thesis, West. Wash. State Coll., Bellingham. 100 pp.

, R. L. Knight, B. L. Holder, and R. J. Anderson. 1985. Bald eagles. Pages 269-290 in E. R. Brown, ed. Management of wildlife and fish habitats in forests of western Oregon and Washington. Part 1. U.S. Dep. Agric., For. Serv., Pacific Northwest Reg.

, and J. R. Newman. 1979. Perch-site preferences of wintering bald eagles in northwest Washington. J. Wildl. Manage. 43:221-224.

Starkey, E. E., D. S. deCalesta, and G. W. Witmer. 1982. Management of Roosevelt elk habitat and harvest. Trans. North Am. Wildl. Nat. Resour. Conf. 47:353-362.

Steenhof, K., S. S. Berlinger, and L. H. Fredrickson. 1980. Habitat use by wintering bald eagles in South Dakota. J. Wildl. Manage. 44:798-805.

Sullivan, J. 0. 1965. "Flightlessness" in the dipper. Condor 67(6):535-536.

1 9 .7 3 . Ecology and behavior of the dipper, adaptations of a passerine to an aquatic environment. PhD Thesis, Univ. Mont., Missoula. 212 pp.

Swanson, D. 0. 1970. Roosevelt elk-forest relationships in the Douglas-fir region of the southern Oregon Coast Range. PhD Diss. Univ. Mich., Ann Arbor. 186 pp.

Terres, J. K. 198G. The Audubon Society encyclopedia of North American birds. Alfred A. Knopf, New York. 1109 pp.

Thut, R. N. 1970. Feeding habits of the dipper in southwestern Washington. Condor 72:234-235.

Toweill, D. E., and E. C. Meslow. 1977. Food habits of cougars in Oregon. J. Wildl. Yanage. 41(3):576-578.

_____, and J. E. Tabor, 1982. River otter. Pages 688-703 in J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of Norht America. The Johns Hopkins Univ. Press, Baltimore, Md.

Townsend, J. E. 1953. Beaver ecology in western Montana with special reference to movements. J. Mammal. 34:459-479.

U. S. Army Corps of Engineers. 1963. Pages 1651-1652 in Annual report of the Chief of Engineers, report on civil works activities FY 1963. U.S. Dep. Army, Corps of Eng., U. S. Gov. Printing Office, Wash., 3. C.

1 9 .8 0 . Project operating limits. U.S. Dep. Army, Corps of Eng., North Pacific Div., Reservoir Control Center, Portland, Oreg. 35 pp + append.

1982. Pages 37-20 to 37-21 in Annual report of the Chief of -Engineers, report on civil works activiteis FY 1982. U. S. Dep. Army, Corps of Eng., U. S. Gov. Printing Office, Wash., D. C.

_____, and U. S. Forest Service. 1963. Hills Creek Reservoir, Middle Fork Willamette River, Oregon. Joint master plan, reservoir management and public use development. Design memorandum no. 15B. Paging various.

_____, _____ and _____. 1968. Hills Creek Reservoir, Middle Fork Willamette River, Oregon. Reservoir management and public use development plan (master plan). np.

U. S. Fish and Wildlife Service. 1958. A detailed report on fish and wildlife resources affected by Hills Creek Reservoir Project, Oregon. U.S. Dep. Inter., Fish and Wildl. Serv., Portland, Oreg. 20 PP.

_____. 1976. Habitat evaluation procedures. U.S. Dep. Inter., Div. Ecol. Serv., Wash., D.. C. 30 pp + tables.

_____ 1980. Habitat evaluation procedures. Ecol. Serv. Man. 102 and io3. U.S. Dep. Inter., Div. Ecol. Serv., Wash., D. C. Paging various.

_____ 1982. Identification of national species of special emphasis. federal Register 47(178):39890-39891.

U.S. Forest Service. 1981a. Wildlife habitats and species management relationships program, Oregon Coast Range. Volume IV, Mammals. U. S. Dep. Agric., For. Serv., Pacific Northwest Reg., Siuslaw Natl. For. 157 pp.

_____. 1981b. Wildlife habitats and species management relationships program, Oregon Coast Range. Volume III, Birds. U.S. Dep. Agric., For. Serv., Pacific Northwest Reg., Siuslaw Natl. For. 581 pp.

_____. 1983. Flood control reservoirs vegetative planting environmental assessment. U.S. Dep. Agric., For. Serv., Willamette Natl. For., Eugene, Oreg. np.

_____. undated. Use of habitats by wildlife species for reproducing. Mimeographed list. U.S. Dep. Agric., For. Serv., Willamette Matl. For. np.

Wallmo, 0. C., ed. 1981. Mule and black-tailed deer of North America. Univ. Nebr. Press, Lincoln 605 pp.

Wilms, W. D. 1971. The influence of forest edge, elevation, aspect site index and roads on deer use of logged and mature forests on northern Vancouver Island. M.S. Thesis, Univ. British Columbia, Vancouver, B.C. 184 pp.

Witmer, G. W., and D. S. DeCalesta. 1983. Habitat use by female Roosevelt elk in the Oregon Coast Range. J. Wildl. Manage. 47(4):933-939.

_____, et al. 1985. Deer and elk. Pages 231-258 in E. R. Brown, ed. Management of wildlife and fish habitats in forests of western Oregon and Washington. U. S. Dep. Agric., For. Serv., Pacific Northwest Reg.

Young, S. P., and E. A. Goldman. 1946. The puma, mysterious American cat. Dover Publications, Inc., New York. 358 pp.

Zarn, M. undated. Habitat management series for unique or endangered species, Report No. 12 - Osprey. Tech. Note 254. U.S. Dep. Inter., Bur. Land Manage. 41 pp.

APPENDIX A

WILDLIFE SPECIES POTENTIALLY OCCURING IN THE HILLS CREEK DAM AND RESERVOIR PROJECT AREA 1 (PRECONSTRUCTION AND/OR POSTCONSTRUCTION)

Herptiles

Northwestern salamander
Long-toed salamander
Cope's giant salamander
Pacific giant salamander
Olympic salamander
Clouded salamander
Oregon slender salamander
Ensatina
Dunn's salamander
Western redback salamander
Roughskin newt
Western toad
Pacific tree frog
Tailed frog
Red-legged frog
Foothill yellow-legged frog
Cascade frog
Bullfrog
Spotted frog
Western pond turtle
Northern alligator lizard
Southern alligator lizard
Short-horned lizard
Western fence lizard
Western skink
Rubber boa
Racer
Sharptail snake
Ringneck snake
Gopher snake
Western terrestrial garter snake
Northwestern garter snake
Comon garter snake
Western rattlesnake

Birds

Common loon
Pied-billed grebe
Horned grebe
Red-necked grebe
Eared grebe
Western grebe
Double-crested cormorant
American bittern
Great blue heron
Great egret
Green-backed heron
Greater white-fronted goose
Canada goose
Wood duck
Green-winged teal
Mallard
Northern pintail
Blue-winged teal
Cinnamon teal
Northern shoveler
Gadwall
American wigeon
Canvasback
Redhead
Ring-necked duck
Greater scaup
Lesser scaup
Harlequin duck
White-winged scoter
Common goldeneye
Barrow's goldeneye
Bufflehead
Hooded merganser
Common merganser
Ruddy duck
Turkey vulture
Osprey
Bald eagle
Northern harrier
Sharp-shinned hawk
Cooper's hawk
Northern goshawk
Red-tailed hawk
Golden eagle
American kestrel
Merlin
Peregrine falcon
Prairie falcon
Ring-necked pheasant
Blue grouse

1 Based on species list for reproductive habitat, Willamette National Forest and Oregon Nongame Wildlife Management Plan, review draft.

Birds (Continued)

Ruffed grouse
California quail
Mountain quail
Virginia rail
Sora
American coot
Sandhill Crane
Killdeer
Greater yellowlegs
Solitary sandpiper
Spotted sandpiper
Western sandpiper
Least sandpiper
Baird's sandpiper
Dunlin
Long-billed dowitcher
Common snipe
Wilson's phalarope
Ring-billed gull
Western gull
Black tern
Rock dove
Band-tailed pigeon
Mourning dove
Barn owl
Western screech owl
Great horned owl
Northern pygmy owl
Spotted owl
Barred owl
Great gray owl
Long-eared owl
Northern saw-whet owl
Common nighthawk
Black swift
Vaux's swift
Calliope humningbird
Rufous hummingbird
Allen's hummingbird
Belted kingfisher
Lewis' woodpecker
Red-breasted sapsucker
Williamson's sapsucker
Downy woodpecker
Hairy woodpecker
White-headed woodpecker
Three-toed woodpecker
Black-backed woodpecker
Northern flicker
Pileated woodpecker
Olive-sided flycatcher
Western wood pewee
Hammond's flycatcher
Dusky flycatcher
Western flycatcher
Western kingbird
Horned lark
Purple martin
Tree swallow
Violet-green swallow
Northern rough-winged swallow
Bank swallow
Cliff swallow
Barn swallow
Gray jay
Steller's jay
Scrub jay
Clark's nutcracker
American crow
Common raven
Black-capped chickadee
Mountain chickadee
Chestnut-backed chickadee
Bushtit
Red-breasted nuthatch
White-breasted nuthatch
Pygmy nuthatch
Brown creeper
Rock wren
Canyon wren
Bewick's wren
House wren
Winter wren
Marsh wren
American dipper
Golden-crowned Kinglet
Ruby-crowned Kinglet
Western bluebird
Mountain bluebird
Townsend's solitaire
Swainson's thrush
Hermit thrush
American robin
Varied thrush
Wrentit
Water pipit
Bohemian waxwing
Cedar waxwing
European starling
Solitary vireo
Hutton's vireo
Warbling vireo
Red-eyed vireo
Tennessee warbler

Birds (Continued)

Nashville warbler
Yellow warbler
Black-throated blue warbler
Yellow-rumped warbler
Black-throated gray warbler
Townsend's warbler
Hermit warbler
American redstart
MacGillivray's warbler
Comnon yellowthroat
Wilson's warbler
Yellow-breasted chat
Western tanager
Black-headed grosbeak
Lazuli bunting
Green-tailed towhee
Rufous-sided towhee
Brown towhee
Chipping sparrow
Brewer's sparrow
Vesper sparrow
Savannah sparrow
Fox sparrow
Song sparrow
Lincoln's sparrow
Golden-crowned sparrow
White-crowned sparrow
Harris' sparrow
Dark-eyed junco
Red-winged blackbird
Western meadowlark
Brewer's blackbird
Brown-headed cowbird
Northern oriole
Rosy finch
Pine grosbeak
Purple finch
Cassin's finch
House finch
Red crossbill
White-winged crossbill
Pine siskin
Lesser goldfinch
American goldfinch
Evening grosbeak
House sparrow

Mammals

Virginia opossum
Vagrant shrew
Dusky shrew
Pacific shrew
Water shrew
Pacific water or Marsh shrew
Trowbridge's shrew
Shrew-mole
Townsend's mole
Coast mole
Little brown myotis
Yuma myotis
Long-eared myotis
Fringed myotis
Long-legged myotis
California myotis
Silver-haired bat
Big brown bat
Hoary bat
Townsend's big-eared bat
Pallid bat
Pika
Brush rabbit
Snowshoe hare
Mountain beaver
Yellow-pine chipmunk
Townsend's chipmunk
Siskiyou chipmunk
Yellow-bellied marmot
California ground squirrel
Golden-mantled ground squirrel
Western gray squirrel
Douglas' squirrel
Northern flying squirrel
Botta's pocket gopher
Western pocket gopher
3eaver
Deer mouse
Dusky-footed woodrat
Bushy-tailed woodrat
Western red-backed vole
Heather vole
White-footed vole
Red tree vole
Townsend's vole
Long-tailed vole
Creeping vole
Water vole
Muskrat
House mouse
Pacific jumping mouse
Porcupine
Nutria
Coyote
Red fox
Gray fox

Mammals (Continued)

Black bear
Rigntail
Raccoon
Marten
Fisher
Ermine
Long-tailed weasel
Mink
Wolverine
Badger
Western spotted skunk
Striped skunk
River otter
Mountain lion
Lynx
Bobcat
Roosevelt elk
Mule deer
Black-tailed deer

APPENDIX B

Interagency Habitat Evaluation Group
Hills Creek Project

Name	Agency
Karen Bedrossian	ODFW
Geoff Dorsey	USACE
Larry Gangle	USFS
Ed Harshman	USFS
Ken Kestner	USFS
Jim Noyes	ODFW
Mary Potter	ODFW
Pat Wright	USFWS

APPENDIX C

Comments

(1) State agency (ODFW)

(2) Federal agencies (USFWS and USFS)

(3) Tribes

No tribes are involved with the actions taken at the Hills Creek Project.

(4) Facility operator (USACE)

BPA requested comments on the May 1985 Hills Creek draft report by 26 July 1985. **USACE had not submitted comments by 3 September** 1985 **when the final report was typed; therefore, USACE comments could not be incorporated into the report.**

(5) Other (PNUCC)

ODFW Comments:

Department of Fish and Wildlife

506 S W MILL STREET, P O BOX 3503, PORTLAND, OREGON 97208

July 23, 1985

Mr. James R. Meyer
Division of Fish and Wildlife
Bonneville Power Administration
PO Box 3621
Portland, OR 97208

Dear Mr. Meyer:

The following comments respond to your request, dated 21 June 1985, to review the Loss Assessment Report for Hills Creek Dam and Reservoir Project.

The Hills Creek Loss Assessment presents an analysis of the impacts to wildlife and wildlife habitat resulting from the construction and operation of the hydroelectric-related components of the project. The Hills Creek Project inundated, extensively altered, or directly affected 4,662 acres of land and river in the Middle Fork Willamette River drainage. Impacts to wildlife centered around the loss of 2,694 acres of old-growth forest and 207 acres of riparian habitat. Important Roosevelt elk winter range was lost, as was year-round habitat for black-tailed deer, black bear, cougar, river otter, beaver, spotted owl, and other nongame species. Impacts of the project included: blockage or inhibition of animal migration or movement; loss of thermal and/or hiding cover; alteration of open area and cover interspersion; loss of breeding, parturition and/or rearing habitat; fragmentation of contiguous habitat; loss or alteration of available forage; loss of nesting, perching and/or roosting sites; and avoidance of the project area by wildlife during construction.

The Hills Creek Loss Assessment clearly shows the potential of the area to support wildlife was altered as a result of the project. That change was quantified in terms of Habitat Units. In this study, the Habitat Units lost or gained represent the change in the potential of the habitat to support the given species at one point in time. That potential, it should be emphasized, was lost over the entire life of the project. Habitat Units also may serve as a guide toward developing mitigation plans, as well as provide a method of measuring the success of mitigation implementation.

The Oregon Department of Fish and Wildlife has a legal mandate "To maintain all species of wildlife at optimum levels and prevent the serious depletion of any indigenous species," and "To develop and manage the lands and waters of this state in a manner that will enhance the production and public enjoyment of wildlife." In accordance with this mandate, the Oregon Department of Fish and Wildlife has a policy to request mitigation when losses to animal populations and habitat result from project construction and operation. These policies are consistent with the Northwest Power Planning Act and Wildlife Program purpose "to protect, mitigate, and enhance fish and wildlife to the

Explanations or Modifications (cont.):

No explanations or report modifications necessary.

ODFW Comments (cont.):

extent affected by the development and operation of any hydroelectric project of the Columbia River and its tributaries..."

In order to "protect, mitigate, and enhance" wildlife resources affected by hydroelectric generating facilities, it is necessary to develop and implement mitigation plans. The Hills Creek Loss Assessment represents the beginning of the process to achieve mitigation for the impacts to the wildlife resource resulting from construction of the project. The next step in the Council's Wildlife Program is the preparation of mitigation plans. I strongly urge the participating agencies to move forward in implementing the Wildlife Program of the Northwest Power Planning Council. The Oregon Department of Fish and Wildlife is ready to take the lead in developing a mitigation plan for the Willamette Basin. Consultation and coordination with the appropriate agencies involved in the project will be an integral part of the process. The Northwest Power Planning Act and the Power Council's Fish and Wildlife Program have provided the opportunity to correct past misunderstanding and shortsightedness regarding wildlife resources affected by the development and operation of hydroelectric power in the Columbia River Basin. The Oregon Department of Fish and Wildlife wants to see that opportunity realized to the fullest degree possible in a timely, effective, and cost-efficient manner.

I appreciate your assistance in this program and look forward to working with you in a cooperative way to achieve our mutual objectives.

Sincerely,

for John R. Donaldson, PhD
Director

Explanations or Modifications (cont.):

No explanations or report modifications necessary.

USFWS Comments:

Explanations or Modifications:

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Division of Ecological Services
Portland Field Office
727 N. E. 24th Avenue
Portland, Oregon 97232

Reference PW:mm

September 13, 1985

Mr. John Palensky, Director
Division of Fish and Wildlife
Attn: James Meyer
Bonneville Power Administration
P. O. Box 3621
Portland, Oregon 97208

Dear Mr. Palensky:

We have reviewed the draft loss statement reports for Cougar, Hills Creek, Dexter, and Lookout Point hydroelectric projects. The following comments are being provided for inclusion in each of the final loss statements.

In our opinion, the reports are well written and adequately describe the on-site wildlife impacts of each project. A comprehensive evaluation, based on habitat supported by population data when available, was conducted by a diverse team of wildlife biologists familiar with the area's wildlife resources. Our agency actively participated in each evaluation and we believe the methods employed to identify the wildlife impacts at each project resulted in a fair and accurate analysis of project impacts.

It is important to note that during each of the evaluations, the impacts were identified on a concensus basis by the evaluation team. This format provided for a thorough discussion of impacts, both beneficial and adverse, and provided a forum for resolving differences in a manner mutually acceptable to each agency's team representative. To the best of our knowledge, the impacts identified in the loss statements accurately reflect both the discussions and decisions of the evaluation teams.

The evaluations did not address cumulative impacts that these and the other major Willamette Valley hydroelectric projects may have had on wildlife. We believe the extensive development that has occurred along the Willamette River's floodplain has significantly reduced a variety of wildlife habitats and related resources. In our opinion, that development and resultant wildlife losses would have been considerably less without the construction and operation of the aforementioned hydroelectric projects. Accordingly,

No explanations or report modifications necessary.

USFWS Comments (cont.):

the Power Council, BPA, and the Corps of Engineers, together with the wildlife management agencies should address the cumulative impacts of the major Willamette Basin hydroelectric projects on wildlife.

In conclusion, we believe the magnitude of on-site wildlife losses identified in the loss statements for the Cougar, Hills Creek, Dexter, and Lookout Point hydroelectric projects warrants that mitigation planning be initiated as early as possible as provided for in the Power Council's Fish and Wildlife Program. We are eager to assist in these efforts and look forward to the day when on-the-ground mitigation can be implemented.

Sincerely,

Russell D. Peterson

Russell D. Peterson
Field Supervisor

Explanations or Modifications:

No explanations or report modifications necessary.

USFS Comments:

United States Department of Agriculture — Forest Service

JUL 1 1 198

Explanations or Modifications:

2600
July 25, 1985

James R. Meyer, Wildlife Program Area Manager
Biological Studies Branch
Department of Energy
Bonneville Power Administration
P. O. Box 3621
Portland, OR 97208

Dear Mr. Meyer:

Our Forest Wildlife Biologist, Ed Harshman, has reviewed the drafts for Cougar, Hills Creek, and Lookout Point reservoirs and has transmitted corrections directly to Karen Bedrossian, Oregon Department of Fish and Wildlife.

Regarding the meeting on July 11, concerning mitigation plans, we urge all possible speed in completing those plans so they can be incorporated into our Forest Land Use Plan.

Sincerely,

Jo E. Reynolds
for MICHAEL A. KERRICK
Forest Supervisor

DG/EH.62F/072585

Corrections or modifications were made where applicable.

PNUCC Comments:

JUL 30

PNUCC

PACIFIC NORTHWEST UTILITIES CONFERENCE COMMITTEE

July 29, 1985

Mr. John R. Palensky - PJ
Director, Division of Fish and Wildlife
Bonneville Power Administration
1002 N.E. Holladay
P.O. Box 3621
Portland, Oregon 97208-3621

Dear Mr. Palensky:

This letter comprises the Pacific Northwest Utilities Conference Committee's (PNUCC) review of the Wildlife and Wildlife Habitat Loss Assessments prepared by Oregon Department of Fish and Wildlife for Dexter Dam, Lookout Point Dam, and Hills Creek Dam on the middle fork of the Willamette River, and Cougar Dam on the south fork of the McKenzie River. Our major technical comments are outline below.

1. The objectives of the impact assessments have not been stated. It is not clear whether the authors intended a general, overall impact assessment, or whether they were interested in specific resource categories such as a habitat type or a species. The presentation of the results seems too detailed and specific for a general assessment, but the resource categories for a specific evaluation are unclear. The focus appears to be species since the habitat units were evaluated across cover types for each species. However, the discussion at the consultation meeting on July 11 suggested that, at least in some cases, the resource category of interest was habitat. As an example, the authors may have selected to investigate losses of species such as pileated woodpeckers, bald eagles, and yellow warblers. Or they may have selected to investigate losses of old growth forest, bald eagles, and certain passerines, a combination of species categories including a guilding method, and habitat categories. Although the same species and selection criteria may be used in either approach, the goals and objectives for a mitigation plan and the plan which results will differ considerably. It is important to identify goals and objectives at the outset since initiating the loss assessments without first identifying objectives may produce costly and unnecessary information, may fail to produce required information, and could lead to a lack of understanding and continuity between interested parties, through personnel changes, and over long term projects. The potentially high cost of wildlife programs make the requirement of clearly documented objectives especially crucial.

2. The authors used a technique called a "modified" Habitat Evaluation Procedure (HEP) and presented their results in terms of Habitat Units (HU). HEP is a published procedure and modifications of this procedure should be precisely identified and documented. The validity of new and altered assumptions should be discussed. For example, one of the modifications in these reports is a backward projection of baseline conditions from a "future" target year. In a usual HEP, using aerial photos, one ground truths baseline habitat conditions as a standard procedure. Aerial photos, even infrared photos, are of limited value without this step. Future projections can also be verified by monitoring conditions after the impact. The backward projection

Explanations or Modifications:

Objectives of the impact assessments are stated in the introduction.

The method used was a habitat-based assessment, using target species to evaluate habitat. See Sections III.D. and III.E.

Objectives of the impact assessments are stated in the Introduction. Objectives of mitigation plans will be stated early in the planning process.

The procedure used was not "called a 'modified' Habitat Evaluation Procedure (HEP)." The procedure was based on HEP, other studies, and discussions with various agency personnel, including USFWS. See Section III.E.
Cover type maps of recent habitat conditions were ground truthed. See Section III.B.

PNUCC Comments (cont.):

can never be ground truthed, or linked in any way to on-site population estimates. Further problems arise in using historical photos. The HEP procedure assumes the project site is evaluated under "average" habitat conditions. Information from aerial photos will vary according to the time of year of the flight and long-term climatic cycles. The loss assessments do not indicate that these variables were taken into account. Therefore, the backward projection adds additional unverifiable assumptions that may limit the procedure and should be stated and discussed.

3. The Habitat Suitability Index models in a HEP are the most controversial and important part of the procedure. The models, or "rating criteria" used in this study are not described in these reports. A model may be either qualitative or quantitative, but it must be documented and it must include as much verification and testing as possible. Models must be repeatable to be credible. A margin of error of repeatability should be provided. Likewise, the sampling design and techniques used to ground truth the aerial photos and apply the models must be described. Sample sizes should be included. The sampling procedure must also produce repeatable results within a stated margin of error and the design must satisfactorily reflect habitat conditions. A specific problem that arises in these loss assessments is the frequent result that more acres of "ideal habitat" ("HUs") than of actual habitat is claimed to have been lost. The authors seem to be indicating that different zones of habitat were variably impacted by the hydropower portion of the project such that some acres were "lost" while others were "altered." This could be a controversial claim but it cannot be evaluated since the HSI models, or rating criteria, and sampling procedures are not described.

4. HEP is based on certain assumptions including the assumption that HSI correlates linearly with carrying capacity. It is also assumed that carrying capacity is full so that habitat is limiting. A projection of the Willamette Basin loss assessments to population numbers would give an estimate of a decline in species such as elk, deer, beaver, and others, and an increase in, for example, the bald eagle. Actual population trends during the 1950s and 1960s when the projects came on line indicate the reverse: deer, elk, beaver, and some others increased or maintained populations, and bald eagles decreased in the Willamette Valley.1/ It appears the HEP assumptions are invalid in this case. Habitat replacement cannot be supported if there are no documented wildlife losses as a result of the projects.

5. We are concerned about how the "losses" in the impact assessments relate to the land management and wildlife agencies' established goals and objectives for wildlife in the Willamette Basin. Willamette National Forest, the major land manager in the area of these projects, will be including targets for many species in their Forest Plan.2/ Wildlife goals under the Council's program must be consistent with the Forest Service targets and other existing state and federal programs. For example, the present management strategies of the Oregon Department of Fish and Wildlife suggest that Willamette Basin game populations are healthy rather than depressed.

1/Pacific Northwest River Basins Commission (1969) Willamette Basin Comprehensive Study of Water and Related Land Resources, App. D Fish and Wildlife.

2/Willamette National Forest draft Forest Plan is due by the end of Fiscal Year 1985.

Explanations or Modifications (cont.):

No attempt was made to link habitat conditions to on-site population estimates.
Cover types identified from aerial photos will not vary from year to year, however, wildlife population size will. See Summary, Section V. for discussion of population estimates and habitat conditions.
See Section III.E. for discussion of rating criteria. Target species rating criteria worksheets are available from ODFW.

For some species, the loss of HU's exceeded the direct loss of acres of habitat. This was a result of the loss of acreage plus the degradation in the quality of the remaining habitat.

Population trends for the Willamette Valley do not necessarily reflect conditions at the project site. See Summary, Section V., for discussion.

Objectives will be identified early in the mitigation planning process. All appropriate agencies will be invited to participate in the development of these objectives.

PNUCC Comments (cont.):

We hope these comments will contribute to a useful and informative final document. Thank you for the opportunity to review the reports.

Sincerely,

Kathryn Kostow

Kathryn E. Kostow
Fish and Wildlife Specialist

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cc: Karen Bedrossian, ODFW
Jan Chrisman, NWPPC
Marty Montgomery, NWPPC
Jim Meyer, BPA

Explanations or Modifications (cont.):

No explanations or report modifications necessary.