4.0 MONITORING PROGRAM

Habitat enhancement activities will be monitored to ensure that they are carried out as prescribed in this plan. Monitoring will occur in two phases: a) direct supervision of all activities by a District biologist and, b) follow-up monitoring of habitat features to verify that the desired results have been achieved. The first phase is relatively straight-forward. It will require the biologist to be actively involved in the design of harvests, plantings and construction activities as well as the development of performance specifications and supervision of all contractors. The second phase will require the qualitative or quantitative measurement of specific habitat features and the comparison of observed values to target values or assumptions made in this plan. Monitoring will be done as described in the following sections.

4.1 SNAGS

4.1.1 Purpose

Snags will be maintained at a target density of three per acre on forested stands within the management lands. Stands will be sampled at regular intervals to: a) verify that the target density of snags is being maintained, b) observe the distribution of snags among decay stages and c) observe wildlife use of snags.

4.1.2 Tracts to be Monitored

Lake Chaplain, Lost Lake, Project Facility Lands, Spada Lake and Williamson Creek

4.1.3 Methods

Forested stands over 40 years old (except old-growth at Williamson Creek) that will not be harvested or thinned prior to 2011 will be sampled between 1988 and 1995 to determine existing snag densities and develop the site-specific prescriptions needed to achieve a target density of three snags per acre. Sampling will follow line-point transect methods adapted for snags by Cline et al. (1980). Initially, transects will run parallel to each other at a spacing of 200 feet. Sampling points will be located at 200-foot intervals along the transects. All snags within 37 feet of the sampling point will be measured. Height, DBH, species and decay stage of each snag will be recorded. Density (snags per acre) will be calculated on a stand-by-stand basis, and the number of new snags needed in each stand will be determined. Sampling intensity will be decreased if initial sampling determines that a smaller sample size will provide data of sufficient accuracy.

Stands will be re-sampled every 10 years through 2060 and new snags will be created, as needed, to maintain the target density of three per acre. Sampling may occur as an independent event, or be combined with snag

creation, timber cruises or habitat surveys when convenient. Sampling will be done initially on a stand (timber type) basis, with transects stratified across stands to provide an even distribution in the sample. Eventually, however, the sampling will be done on the basis of cutting units as the stands are divided up for harvesting. All forested stands over 40 years old will be sampled every 10 years, except stands will not be sampled and new snags will not be created in stands during the 20 years before they are harvested.

Wildlife use of snags will be recorded during surveys. The presence of nest cavities and foraging activity will be noted and the species will be identified, if possible. Use will be recorded as current (year of sample) or past, if discernable.

4.1.4 Data to be Collected

a) density of snags by size (DBH), species, height and decay stage for each stand or unit;

b) persistence of man-made snags (number of years from creation to falling); and

c) wildlife use of snags (percent used) by size, species, height and decay stage.

4.1.5 Use of Data

Data on snag density will be used to plan snag-creation activities on a stand-by-stand basis. Size, species and height data will be used in conjunction with wildlife species requirements to direct the selection of live trees for topping. Data on decay stages and persistence will be compared to published decay models (Cline et al., 1980) to predict future snag densities and determine if creation rates need to be adjusted. Wildlife use data will be used to verify habitat benefits of the snag program. The snag program may be adjusted if disproportionate wildlife use of one or more snag species or size classes is observed.

4.2 DEAD AND DOWN WOODY MATERIAL

4.2.1 Purpose

Dead and down woody material will be left on the ground during timber harvest operations to provide between six and 10 logs or slash piles per acre. Harvest operations will be monitored to ensure that this objective is met. Harvested units will be sampled periodically until harvested again to monitor decomposition and wildlife use of logs and piles.

4.2.2 Tracts to be Monitored

Lake Chaplain and Lost Lake

4.2.3 Methods

A biologist will visit all proposed harvest units and commercial thins within one year prior to harvest to mark logs, snags and live trees to be left as logs. The biologist will then visit each unit during and immediately following the harvest (while logging equipment is still present) to verify that the selected logs were left.

Logs will be sampled at 20-year intervals in those units that have been harvested or thinned. Random sampling points will be selected at a density of one per acre. All logs within 37 feet of each sampling point will be recorded. Length, diameter, species and decay class (Maser et. al., 1979) will be recorded. Signs of wildlife use will also be noted. As with snags, sampling intensity will be decreased if it is found that a smaller sample size will suffice.

4.2.4 Data to be Collected

a) number of acres on which logs have been left;

b) density of logs by diameter, length, species, and decay class on units that have been harvested or thinned; and

c) wildlife use of logs by diameter, length, species and decay class.

4.2.5 Use of Data

Data collected on the density of logs will be compared over time to derive estimates of recruitment and persistence. This information may be useful later (when several years of data are available) to adjust the selection of the type and number of trees and logs to be left in cutting units. Data on wildlife use of logs and brush piles will be used to: a) verify wildlife benefits of the program, as indicated by signs of use, and b) adjust the selection of trees and logs in cutting units if one or more size classes, decay classes or species is receiving disproportionate use.

4.3 VEGETATION PLANTINGS AT LAKE CHAPLAIN

4.3.1 Purpose

Tree and shrub plantings will provide visual screening between the Lake Chaplain Road and Chaplain Creek Marsh and along the north shore of Lake Chaplain east of the dam. Some mortality may occur in the first few years after planting. Plantings will be monitored until they are well established to verify that mortality has not reduced screening effectiveness. Monitoring will continue on a periodic basis thereafter to ensure the continued survival of the plantings.

4.3.2 Tract to be Monitored

Lake Chaplain

4.3.3 Methods

Plantings will be monitored by contract horticulturists twice a year for two successive years following planting. Additional monitoring will continue once each target year thereafter by a District biologist.

4.3.4 Data to be Collected

a) tree and shrub survival and condition; and
b) replantings.

4.3.5 Use of Data

Dead trees and shrubs will be replaced as needed in the first two years to achieve the desired density and screening, unless it is determined that adjustments in species or planting procedures will increase success, or that conditions are unfavorable for vegetation planting.

4.4 VEGETATION PLANTINGS AT PROJECT FACILITY LANDS

4.4.1 Purpose

Trees, shrubs and grasses will be planted and fertilized to enhance wildlife habitat on Project Facility lands. As with trees and shrubs at Lake Chaplain (Section 4.3) plantings will be monitored to verify that they become successfully established.

4.4.2 Tracts to be Monitored

Project Facility Lands

4.4.3 Methods

Douglas-fir, black cottonwood, fruit trees and hedges will be monitored by contract horticulturists twice a year for two successive years following planting. Additional monitoring will continue once each target year thereafter by a District biologist. Fertilized areas above the powerhouse site will be examined visually for three successive years to see that a vigorous cover of grasses and forbs is established.

Seeded and fertilized portions of the pipeline right-of-way will be monitored annually for five successive years to determine percent grass/forb ground cover. Transects utilizing 2 x 5 decimeter plots developed by Daubenmire (1968) will be utilized. Areas disturbed by human use will be noted.

4.4.4 Data to be Collected

a) planting survival at the powerhouse site and along the pipeline right-of-way; and

b) success of grass seeding at the powerhouse site (visual assessment) and along the pipeline right-of-way (quantified sample of percent coverage).

4.4.5 Use of Data

Dead trees and shrubs will be replaced as needed in the first two years to achieve the desired density and screening, unless it is determined that adjustments in species or planting procedures will increase success, or that conditions are unfavorable for vegetation planting. Fertilization will be repeated if the coverage of grasses does not reach 50 percent within four years of seeding.

4.5 VEGETATION TESTS AT SPADA LAKE

4.5.1 Purpose

Efforts will be made to re-vegetate the drawdown zone at Spada Lake. Experimental plots will be used initially to determine survival and growth of flood-tolerant species and develop re-vegetation techniques suitable for the reservoir shoreline environment.

4.5.2 Tract to be Monitored

Spada Lake

4.5.3 Methods

Experimental plots at Spada Lake will be monitored each year for 10 successive years by contract horticulturists and/or District biologists. Survivorship and growth rates will be compared with inundation records. Additional species may be tested at the recommendation of contract horticulturists and District biologists.

4.5.4 Data to be Collected

a) survival of test species; and
b) growth and spreading of test species.

4.5.5 Use of Data

Monitoring will determine the success of re-vegetating the drawdown zone. Additional experimental plots may be added if successful establishment occurs or if other research indicates potential establishment with additional species. Test procedures may be modified at the recommendation of the contract horticulturist and District biologists. If test species grow successfully and economically in the drawdown zone, re-vegetation of the zone will be considered by the District, City and agencies.

4.6 BUFFER ZONES AND GREEN TREE CLUMPS

4.6.1 Purpose

The success and effectiveness of forested buffer zones and green tree clumps depend upon the health and vigor of the vegetation, particularly the overstory. Like all forested stands, buffer zones will be susceptible to blow-down, disease, insect invasion, land slides and human disturbance. Annual inspection of all buffer zones and green tree clumps will allow early detection of disturbance and facilitate the implementation of corrective measures.

4.6.2 Tracts to be Monitored

Lake Chaplain and Lost Lake

4.6.3 Methods

All buffer zones and green tree clumps will be examined annually from the time they are established through 2060 unless monitoring results indicate that less frequent examination is appropriate. A biologist will conduct a "walk-through" inspection of each unit and note its condition, including signs of blowdown, disease, insect invasion, ground disturbance, unauthorized human activity, soil erosion and other indications of potential problems. Blowdown will be of particular interest, and the biologist will record species, DBH and orientation of all blown-down trees.

4.6.4 Data to be Collected

a) signs of problems or loss of vegetation cover; and

b) species, DBH, site conditions and orientation (compass directions) of blown-down trees.

4.6.5 Use of Data

Signs of disturbance to the soil and vegetation will indicate the need for corrective action to maintain the physical and biological integrity of each buffer zone and green tree clump. Data on blowdown will be analyzed to look for trends in species and size of trees and compass orientation of stands. This information will be used to plan future buffer zones, with the aim of minimizing blowdown.

4.7 BLACK-TAILED DEER FORAGE

4.7.1 Purpose

Measures are proposed in conjunction with harvesting and commercial thinning to increase the amount of forage for deer. The production and utilization of forage plants will be monitored on representative harvested and thinned units to document the benefits of enhancement measures.

4.7.2 Tracts to be Monitored

Lake Chaplain and Lost Lake

4.7.3 Methods

Forage production will be monitored in representative harvest units and commercial thins according to the line intercept method described by Canfield (1941). Canopy coverage (percent of the total ground area covered) will be measured for shrubs, grasses and forbs along fifteen 100-meter transects in each unit. Canopy coverage will be used as an estimate of productivity (biomass).

Transects will be established and sampling will begin one year prior to cutting in commercial thins and one year after cutting in harvest units. The first year of data from commercial thins (pre-harvest) will serve as baseline data. Control data for the harvest units will be derived from sampling in similar units under typical commercial forest management. Control units will be established on the management tracts if suitable sites cannot be located off the tracts.

Two harvest units and two commercial thins will be sampled from each group of units cut in each five-year period. Units will be sampled every year for the first five years after cutting and once every third year from years six through 20. Sampling will occur in the mid to late summer, when foliage is fully developed.

Forage utilization will be estimated concurrently by qualitatively assessing hedging according to pre-determined classes such as low, medium and high (Aldous 1944, Dasmann 1948, USFS 1966).

4.7.4 Data to be Collected

a) percent canopy coverage by species for shrubs and forbs and as a group for grasses; and

b) qualitative estimate of forage utilization as indicated by hedging.

4.7.5 Use of Data

Data collected on treated units will be compared to control data to demonstrate the habitat benefits of the wildlife habitat management plan. Trends in forage production (as estimated by canopy coverage) will be analyzed to determine how long the increase in production persists after overstory cutting. Differences between observed trends and assumptions made in this plan may be cause for adjustments to harvest schedules and/or methods.

4.8 ARTIFICIAL NESTING ISLANDS

4.8.1 Purpose

Artificial islands will be constructed to enhance waterfowl breeding habitat. Size, placement and location may effect use of the islands. Monitoring will determine if the islands are used and the species of birds using them.

4.8.2 Tract to be Monitored

Lost Lake

4.8.3 Methods

Each island will be visited annually prior to the breeding season to make needed repairs and add fresh nesting material. Islands will be checked again at least once during the breeding season to observe wildlife use.

4.8.4 Data to be Collected

a) utilization;

b) productivity; and

c) structural integrity of nesting islands.

4.8.5 Use of Data

Monitoring of nesting islands will determine success of this enhancement measure. Wildlife use data will be used to assist planning for relocation of islands if necessary.

4.9 WATERFOWL NEST BOXES

4.9.1 Purpose

Nest boxes will be erected to enhance waterfowl nesting habitat. Monitoring will determine use and condition of nest boxes.

4.9.2 Tract to be Monitored

Lost Lake

4.9.3 Methods

Boxes will be checked, cleaned and fresh nesting material will be replaced each year prior to the breeding season. Each box will also be visited at least twice during the breeding season to determine use and productivity.

4.9.4 Data to be Collected

a) species use;
b) productivity; and
c) structural integrity of nest boxes.

4.9.5 Use of Data

Data will be used to determine the success of this enhancement measure.

4.10 OSPREY NEST STRUCTURES

4.10.1 Purpose

Osprey nest structures will be monitored to determine use and ensure that they remain standing and functional.

4.10.2 Tracts to be Monitored

Lost Lake and Spada Lake

4.10.3 Methods

Structures will be observed each spring to determine use and again in summer to determine productivity.

4.10.4 Data to be Collected

a) species use;

b) productivity; and

c) structural integrity.

4.10.5 Use of Data

Monitoring activities will determine the success of this enhancement measure. Structures may be moved or modified if they do not receive use, and repaired if necessary.

4.11 REPORTING

4.11.1 Purpose

Reports will be prepared at regular intervals and submitted to the agencies and the FERC to document implementation of the program, verify the success of enhancement measures and initiate discussion on items requiring review or modification.

4.11.2 Tracts

Lake Chaplain, Lost Lake, Project Facility Lands, Spada Lake and Williamson Creek.

4.11.3 Methods

Reports will be prepared annually during the implementation phase (through 1995) and every 5 years thereafter. Reports will summarize activities during the intervening period and identify those planned for the next period. Monitoring data will be presented in summary form and analyzed. Problems and proposed changes in this plan, if any, will be discussed. Reports will be provided to appropriate agency personnel at least one month prior to scheduled review meetings. The District and City staff will review the reports at the meetings.

4.11.4 Information to be Provided

a) summary of forest management measures, including acres harvested, thinned, planted, fertilized, etc.;

b) documentation of habitat enhancement measures, including snag creation, nest boxes, nesting islands, osprey nests and vegetation planting;

c) results of monitoring program;

d) activities planned for the next year (or five years after 1995);

e) discussion of problems or changes needed; and

f) updated maps of management lands showing the current distribution of cover types and harvest units.

4.11.5 Use of Reports

The reports will serve as written documentation on program implementation and success and a focal point for meetings between the co-licensees and the agencies. Reports and meeting notes will be submitted to the FERC as progress reports in accordance with the schedule in Section 4.11.3.

5.0 SCHEDULE

Table 5.1 Activity schedule for all management tracts for 1988 through 1995, summarized yearly.

Activity	Years													
	1988		1989		1990		1991		1992		1993		1994		1995	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Final Harvest					1-3,1-9 1-15,3-1 4-5,5-8	116			4-3,4-4	23	2-9,2-11 4-2	49			5-4,5-5	25
Commercial Thin					1-9,1-15 2-13,3-1 4-5	95					2-9	11				
Snag Creation(1)			336 SNAGS		1094 SNAGS		336 SNAGS		382 SNAGS		456 SNAGS		336 SNAGS		387 SNAGS	
Nest Boxes	7-5	N/A	Maintenance will occur annually through 2060													
Nesting Islands	7-5	N/A	Maintenance will occur annually through 2060													
Osprey Platforms	7-5	N/A	9-11	N/A	Maintenance will occur as needed											
Test Plantings			9-10	N/A												
Tree/Shrub Plantings			1-17,4-8 8-3,8-4	73												
Grass Seeding			8-3	40												
Fertilization			8-3,8-4	65												
Debris Removal			9-1 THRU 9-10	N/A												

(1) Number of snags is an estimate based on the assumption that two snags per acre will be created initially and one snag will be created per acre for replacement every 10 years thereafter.

Table 5.2 Activity schedule for the Lake Chaplain Tract for 1988 through 2000, summarized in 5-year intervals.

Activity	Years															
	1988 - 1990		1991 - 1995		1996 - 2000		2001 - 2005		2006 - 2010		2011 - 2015		2016 - 2020		2021 - 2025	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Final Harvest	1-3,1-9, 1-15,3-1 4-5,5-8	116	2-9,2-11 4-2,4-3 4-4,5-4 5-5	97	1-5,2-2 2-9,2-11 3-1,5-12	93	1-7,2-3 2-9,4-2 4-3,4-5	105	1-9,1-15 4-5,5-2 5-4,5-9	102	2-2,2-9 2-11,5-4 5-5	98	1-2,1-5 1-7,2-9 3-1,4-1 4-2,5-9 5-10	99	1-5,1-7 2-6,2-9 2-11,4-2 4-4	118
Commercial Thin	1-9,1-15 2-13,3-1 4-5	95	2-9	11	1-2,1-5 1-7,3-1 5-11	79	1-7,2-6 4-5	77	1-9,1-15	47	2-11,5-5	35	1-5,1-7 1-9,2-9	33	1-5,1-7 1-9,2-11 2-12	79
Snag Creation	1094 SNAGS		1897 SNAGS		896 SNAGS		364 SNAGS		854 SNAGS		244 SNAGS		724 SNAGS		350 SNAGS	
Tree/Shrub Plantings	1-17,4-8	8														

Table 5.2 (Continued)

Activity	Years													
	2026 - 2030		2031 - 2035		2036 - 2040		2041 - 2045		2046 - 2050		2051 - 2055		2056 - 2060	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Final Harvest	1-9,1-15 3-1,4-5 5-4,5-5	126	1-7,2-2 2-3,2-11 5-4,5-5	100	1-5,1-7 1-9,2-9 4-2,4-3 5-5,5-9	125	1-5,1-7 1-9,2-6 2-11,2-12 4-2,4-3	111	1-3,1-9 1-15,3-1 4-5,5-8	116	2-9,2-11 4-2,4-3 4-4,5-4 5-5	97	1-5,2-2 2-9,2-11 3-1	90
Commercial Thin			1-3,1-9 1-15,3-1 4-5,5-8	116	2-9,2-11 4-2,4-3 4-4,5-4 5-5	97	1-5,2-2 2-9,2-11 3-1	90	1-7,2-3 2-9,4-2 4-3,4-5	105	1-9,1-15 4-5,5-2 5-4,5-9	102	2-2,2-9 2-11,5-4 5-5	98
Snag Creation	544 SNAGS		124 SNAGS		574 SNAGS		64 SNAGS		566 SNAGS				732 SNAGS	

Table 5.3 Activity schedule for the Lost Lake Tract for 1988 through 2060, summarized in 5-year intervals.

Activity	Years													
	1988 - 1990		1991 - 1995		1996 - 2000		2001 - 2005		2006 - 2010		2011 - 2015		2016 - 2020		2021 - 2025	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Final Harvest					7-1, 7-2 7-3	14							7-1, 7-2	13		
Commercial Thin															7-4	24
Snag Creation	194 SNAGS				65 SNAGS				30 SNAGS				76 SNAGS		48 SNAGS	
Nest Boxes	7-5	N/A	Maintenance will occur annually through 2060													
Nesting Islands	7-5	N/A	Maintenance will occur annually through 2060													
Osprey Platforms	7-5	N/A	Maintenance will occur as needed													

Table 5.3 (Continued)

Activity	Years											
	2026 - 2030		2031 - 2035		2036 - 2040		2041 - 2045		2046 - 2050		2051 - 2055		2056 - 2060	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Final Harvest	7-4	14			7-1,7-2 7-4	28			7-4	12			7-1,7-2 7-3,7-4	18
Commercial Thin							7-1,7-2 7-3	14						
Snag Creation	76 SNAGS				80 SNAGS				58 SNAGS				64 SNAGS	

Table 5.4 Activity schedule for the Project Facility Lands Tract for 1988 through 2060, summarized in 5-year intervals.

Activity	Years													
	1988 - 1990		1991 - 1995		1996 - 2000		2001 - 2005		2006 - 2010		2011 - 2015		2016 - 2020		2021 - 2025	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Snag Creation											20 SNAGS		18 SNAGS			
Grass Seeding	8-3	40														
Tree/Shrub Plantings	8-3,8-4	67														
Fertilization	8-3,8-4	67														

Activity	Years													
	2026 - 2030		2031 - 2035		2036 - 2040		2041 - 2045		2046 - 2050		2051 - 2055		2056 - 2060	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Snag Creation	8 SNAGS				8 SNAGS				8 SNAGS				8 SNAGS	

Table 5.5 Activity schedule for the Spada Lake Tract for 1988 through 2060, summarized in 5-year intervals.

Activity	Years													
	1988 - 1990		1991 - 1995		1996 - 2000		2001 - 2005		2006 - 2010		2011 - 2015		2016 - 2020		2021 - 2025	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Snag Creation									136 SNAGS				28 SNAGS			
Osprey Platforms	9-11	N/A	Maintenance will occur as needed													
Test Plantings	9-10	N/A														
Debris Removal	9-1,9-2 9-3,9-4 9-5,9-6 9-7,9-8 9-9,9-10	N/A														

Activity	Years													
	2026 - 2030		2031 - 2035		2036 - 2040		2041 - 2045		2046 - 2050		2051 - 2055		2056 - 2060	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Snag Creation	28 SNAGS				28 SNAGS				28 SNAGS				28 SNAGS	

Table 5.6 Activity schedule for the Williamson Creek Tract from 1988 through 2060, summarized in 5-year intervals.

	Years													
Activity	1988 - 1990		1991 - 1995		1996 - 2000		2001 - 2005		2006 - 2010		2011 - 2015		2016 - 2020		2021 - 2025	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Snag Creation	132 SNAGS				26 SNAGS				26 SNAGS				26 SNAGS			

	Years							
Activity	2026 - 2030		2031 - 2035		2036 - 2040		2041 - 2045		2046 - 2050		2051 - 2055		2056 - 2060	
	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres	Stands	Acres
Snag Creation	26 SNAGS				26 SNAGS				26 SNAGS				26 SNAGS	

Table 5.7 Monitoring schedule for all management tracts for 1988 through 2060, summarized in five-year intervals.

Activity	Years														
	1988 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	2041 to 2045	2046 to 2050	2051 to 2055	2056 to 2060
Snags at Lake Chaplain (ac)	1193		1381		1388		1328		1252		1182		1417		1829
Snags at Lost Lake (ac)	97		97		74		125		120		122		146		158
Snags at Spada Lake (ac)					68		68		68		68		68		68
Snags at Williamson Cr.(ac)	66		66		66		66		66		66		66		66
Snags at Project Lands (ac)									19		19		19		19
Logs at Lake Chaplain (ac)					116	97	93	105	102	98	99	118	126	100	125
Logs at Lost Lake (ac)							14				13		14		28
Plantings at Lake Chaplain	Twice per year in 1990 and once every five years through 2060														
Trees and shrubs at Project Facility Lands	Twice per year in 1990 and 1991 and once every five years through 2060														
Seeding at Powerhouse	Once per year in 1990, 1991, and 1992 only														
Seeding at Pipeline	Once per year in 1990, 1991, 1992, 1993, and 1994 only														
Test plantings at Spada Lake	Once per year from 1990 through 2000 only														
Buffer zones at Lake Chaplain and Lost Lake	Once per year in all established buffers through 2060														

Table 5.7 (Continued)

Activity	Years 1988 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	2041 to 2045	2046 to 2050	2051 to 2055	2056 to 2060
Deer forage at Lake Chaplain and Lost Lake (harvest units)	Sample up to four harvest units and four commercial thins each year through at least 2010														
Nesting islands at Lost Lake	Once per year from 1989 through 2060														
Nest boxes at Lost Lake	Twice per year from 1989 through 2060														
Osprey nests at Spada Lake and Lost Lake	Twice per year from 1989 through 2060														
Reporting	Annually through 1995 and once every five years through 2060														

6.0 HEP ASSESSMENT

6.1 INTRODUCTION

The resource agencies requested that HEP be used as a guideline for assessing the adequacy of this plan for mitigating wildlife losses. HEP was used to assist in determining the direction and magnitude of mitigation measures. It must be stressed, however, that the final configuration and adequacy of the plan were determined through consultation with the resource agencies. HEP was simply a tool used in the plan development process.

HEP was used to quantify changes in wildlife habitat resulting from construction and operation of the Project (Impact HEP) and from implementation of the management program (Mitigation HEP). The Impact HEP is an update of the HEP conducted by the WDW in 1982 (WDG 1982). Updated methods of calculating habitat changes were applied to the field data collected by the WDW and supporting data from other studies. The Impact HEP is described in detail in Section 6.2. The Mitigation HEP is a new HEP conducted according to current USFWS methodologies (USFWS 1980). Both HEP assessments were performed in consultation with representatives from the WDW, USFWS, USFS and Tribes. Agency and tribal representatives participated in major decisions concerning the selection of evaluation species, development of habitat models, collection of field data and interpretation of results. The HEP team members are listed in Table 6.1.

Table 6.1 Team members for the Jackson Project Impact HEP update and Mitigation HEP

Name	Affiliation	Role
Gary Engman*	Washington Dept. of Wildlife	Review & Supervision
Gwill Ging*	U.S. Fish and Wildlife Service	Review & Supervision
James Bartelme	U.S. Forest Service	Review & Supervision
Marsha Kearney	U.S. Forest Service	Review & Supervision
Leslie Weldon	U.S. Forest Service	Review & Supervision
David Sommers	Tulalip Indian Tribes	Review
Karen Bedrossian*	District	All Phases
Martin Vaughn*	Beak Consultants	All Phases
Leslie Ades*	Beak Consultants	Data Collection and Analysis
Dave Hays	Beak Consultants	Data Collection and Analysis
Judith Baumert*	Beak Consultants	Data Analysis

*Indicates HEP Certified

6.2 IMPACT HEP UPDATE

6.2.1 Background

The major terrestrial impact associated with the Project was the clearing and inundation of the reservoir area. Much of the area was old-growth coniferous forest prior to Project clearing, with lesser amounts of mature coniferous and riparian forest, recently-logged forest and wetland. Nearly all of the reservoir (1,870 acres) was logged by the USFS and DNR between 1960 and 1963 in anticipation of the Project, even though the Stage I reservoir was only 750 acres. The forest above the Stage I reservoir was allowed to re-generate naturally and grow until it was cut again in 1983 for Stage II. The pipeline and powerline rights-of-way, roads, powerhouse site, borrow areas and spoils areas (downstream areas; 211 acres) were mostly second growth forest when they were logged in 1983 for Stage II.

Project-related impacts were assessed originally by the WDW (WDG 1982) using the 1976 version of HEP (USFWS 1976). Pre-Project habitat conditions (i.e, prior to reservoir clearing in the early 1960's) were estimated from aerial photographs taken in the 1930's. Stage I impacts were estimated by comparing habitat conditions in 1982 to those observed in the 1930's photographs. Stage II impacts were estimated by comparing the 1982 conditions to those under full Project development.

The District and the agencies reviewed the 1982 Impact HEP and determined that the results could not be used as a comparison to the Mitigation HEP without major revisions. The need for revisions stemmed from the following items:

a) Project Boundary: The 1982 HEP included 3,848 acres surrounding the Spada Lake Reservoir (outside the Project boundary) because it was believed that widespread logging in that area between 1960 and 1965 was attributable to the Project. Examination of USFS records did not clarify whether the area would have been logged over such a short period without the Project. The District and

agencies reviewed the matter at length and agreed to exclude from the HEP all land outside the Project boundary, except borrow pits and spoils areas. The 1982 HEP also estimated the reservoir at 1,804 acres. Later surveys by the District found the area of the reservoir to be 1,870 acres. Minor refinements were also made to other Stage II impact areas because the 1982 HEP was based on pre-construction estimates;

b) Habitat Unit Calculations: The mathematical procedures for calculating Habitat Unit (HU) gains and losses have changed considerably from those used in the 1982 HEP. The 1982 HEP was based on a single habitat score for each cover type, referred to as the Habitat Type Unit Value. The new version of HEP requires individual scores, or Habitat Suitability Indices (HSI), for each wildlife species in each cover type. The 1982 HEP also gave habitats with "virtually no value to a given species..." a score of 1 (on a scale of 1 to 10). An effective score of 0 is given in such cases in the current version of HEP;

c) Evaluation Species: The 1982 HEP used 48 evaluation species, but it did not rate all cover types for all species that use them. This made it impossible to determine net gains and losses of habitat because the HUs calculated for the individual cover types are not comparable unless they are calculated for the same set of species. The 1982 HEP also did not consider species that benefited from the Project, so there was no accounting for positive impacts; and

d) Habitat Assumptions: The 1982 HEP assumed that the area inundated by Spada Lake supported only mature forest, old-growth forest, wetland and stream habitat when reservoir clearing began in 1960. This assumption was based on the 1930's aerial photographs, which showed no logging activity in the basin. Subsequent examination of logging records on file at the Skykomish Ranger Station showed that 455 acres of old-growth and mature

forest had been clearcut logged between 1930 and 1960, prior to the onset of reservoir clearing. The District and agencies agreed that the HEP should be revised to show the pre-Project logging.

The 1982 HEP also included the assumption that the old-growth and mature forest in the basin would have been clearcut at approximately 1 percent per year if the Project had not resulted in complete removal between 1960 and 1965. Conversations with the USFS (Williams 1986) indicated that a harvest rate of 1 percent per year is probably appropriate for a ranger district or national forest as a whole, but not necessarily for a single river basin. The USFS typically concentrates logging in one or a few drainage basins once they have developed a road system, and logging within the basin(s) may proceed much faster than 1 percent per year. The Sultan River canyon below Culmback Dam, for example, was logged of most commercial timber over the 25-year period from 1960 to 1985; an average rate of 4 percent per year. The District and agencies agreed to use a rate of 2 percent per year in the update of the HEP. They also agreed, based on estimates made by the USFS (Williams 1986), that 80 acres would never have been logged because of steep slopes or unstable soils, and 164 acres along the shorelines of the Sultan River and Williamson Creek would have been logged at the slower rate of 1 percent per year to protect the streamside environment.

6.2.2 Objectives

The primary objective of the Impact HEP update was to quantify habitat changes resulting from construction and operation of the Project in such a way that they could be meaningfully compared to habitat gains realized under the wildlife habitat management plan. The Project resulted in both habitat losses and gains, and it was also an objective of this update to estimate both. Habitat changes were estimated according to current HEP methodology (USFWS 1980), while relying on the field data collected by the WDW in 1982. No new field data were collected for the update of the Impact HEP.

At the request of the WDW and USFWS, an additional objective was added to the update. The agencies requested that four priority cover types be tracked separately through the HEP process so that gains and losses specific to those cover types could be shown. The four cover types were old-growth forest, mature riparian forest, young riparian forest and wetland. In a standard HEP, habitat values are combined for all cover types. It is theoretically possible to replace habitat losses in one cover type with habitat in other cover types, as long as the evaluation species being considered could make use of both cover types. The agencies wanted to avoid this with the priority cover types which have distinct social and biological value because of their scarcity and uniqueness. The standard HEP process is not sensitive to those values, so priority cover type evaluation species were created to track the priority cover types. This is described in Section 6.2.3.4.

An important point to note is that the 1987 HEP update is a major revision of the 1982 HEP (WDG 1982) and the results are not comparable. Changes in the number of evaluation species, the total area of impact and the methods of calculating HUs mean that the results of the two HEP assessments cannot be compared.

6.2.3 Methods

6.2.3.1 Study Area

The total area impacted by the Project was 2,081 acres; including 1,870 acres inundated by the reservoir and 211 acres utilized for pipeline rights-of-way, the powerhouse site, the transmission line right-of-way, borrow pits, spoil areas and roads. The distribution of acreages among the various Project features is shown in Table 6.2.

Table 6.2 Lands included in the Jackson Project Impact HEP update.

Project Element	Area (acres)
Reservoir	1,870
Pipeline Right-of-Way (Blue Mountain Tunnel Portal to Powerhouse)	100
Powerhouse Site	27
Pipeline Right-of-Way (Powerhouse to Lake Chaplain)	9
Transmission Line Right-of-Way	1
Borrow Pits and Spoil Areas	48
Roads	26
TOTAL	2,081

6.2.3.2 Cover Types

The cover types used for the update were the same as the habitat types used in the 1982 HEP. Detailed descriptions of all habitat types were provided in the 1982 HEP report (WDG 1982). They are summarized as follows:

Reservoir: All areas within the normal maximum operating pool (elevation 1,450 feet MSL) of Spada Lake reservoir.

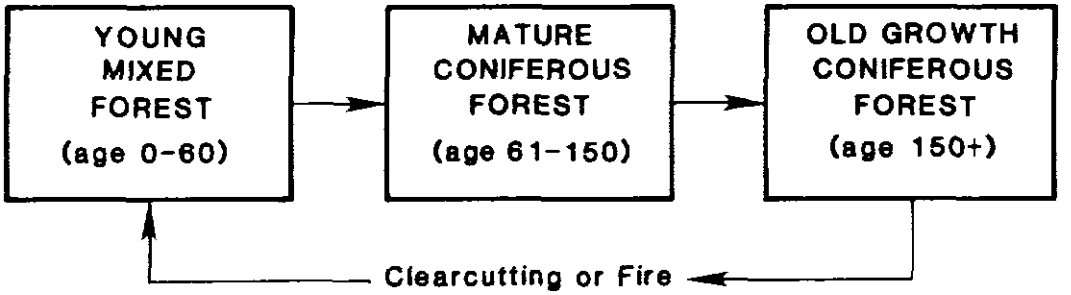
Stream/River: Those portions of the Sultan River, Williamson Creek and smaller tributary streams that were inundated by Spada Lake.

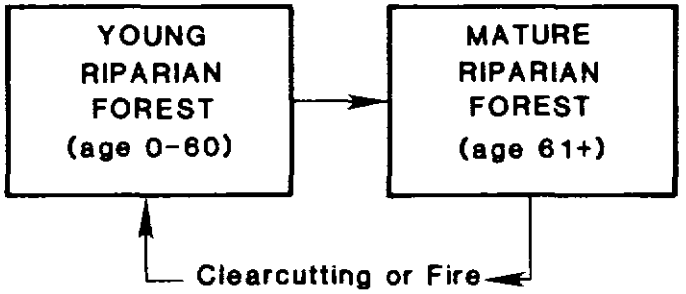
Wetland: All wetlands (flooded-forest, scrub-shrub, emergent and open water) that were inundated by Spada Lake, as well as a small wetland complex along Marsh Creek that was impacted by the pipeline. It was assumed that acreage in this cover type would have remained constant without the Project, except for 2 acres that appeared north of the Sultan River after the old-growth was logged.

Young Riparian Forest: Forested riparian areas along the Sultan River and Williamson Creek that were logged between 1954 and 1963 and supported young stands of red alder, black cottonwood, willow and numerous shrubs until Stage II construction. Dominant red alder measured 6 inches to 8 inches DBH. It was assumed that all acres in this cover type originated in the year 1960 and would have become mature riparian in 2020 at 60 years of age (Figure 6.1).

Mature Riparian Forest: Riparian forest along the Sultan River and Williamson Creek that had no history of logging or human disturbance prior to Stage I construction. Stand ages are unknown. Overstory species included large black cottonwood, mature red alder, western red cedar, western hemlock and bigleaf maple. It was assumed that young riparian forest would have become mature riparian at 60 years of age if it had not been cleared for the Project (Figure 6.1). Mature riparian forest would have remained unchanged unless clearcut, at which time it would have become young riparian.

Young Mixed Forest: Upland forest that was logged between 1954 and 1963 and left to regenerate naturally. Tree species composition was a mixture of red alder, western hemlock and Douglas-fir. Stocking levels were dense and irregular. Understory vegetation was dense initially but sparse in later years. A number of forest successional stages were included in this cover type, such as early-successional, open canopy sapling/pole and closed canopy sapling/pole stand conditions. Young mixed forest became mature coniferous forest at 60 years of age in the HEP analysis (Figure 6.1).





HENRY M. JACKSON PROJECT FERC NO. 2157
PUBLIC UTILITY DISTRICT NO. 1
OF SNOHOMISH COUNTY AND
THE CITY OF EVERETT, WASHINGTON

WILDLIFE HABITAT MANAGEMENT PLAN

Figure 6.1 Successional patterns of forested cover types for the Impact HEP update.

Mature Coniferous Forest: Upland coniferous forest greater than 60 years old but less than 110 years old. Overstories were dominated by large western hemlock and Douglas-fir. Stocking levels and understory vegetation were variable. This cover type included natural stands that existed in 1960 as well as stands that would have resulted from logging if the Project had not been built. Naturally-occurring mature coniferous forest would have become old-growth at 150 years of age if it were not cut (Figure 6.1). Second growth stands never become old-growth in the HEP analysis.

Old-growth Coniferous Forest: Upland coniferous forest that was approximately 110 years old in 1960. These areas had no history of human disturbance and probably originated after wildfire in the last century (fires were common in the area during the gold and silver mining period of the 1800's). Trees were predominantly large western hemlock and Douglas-fir, interspersed with very large snags.

Grass/Shrub: Areas managed permanently in the non-forested condition because of Project operation. This cover type included the pipeline right-of-way, transmission line right-of-way and portions of the powerhouse site.

Bare Soil: Any disturbed area with no habitat value. This cover type included roads, buildings and construction lay-down areas. Some impacted areas remained permanently free of vegetation, while others were returned to grass/shrub or young mixed forest.

The change in vegetation cover types over time is governed by natural plant succession and disturbance such as fire and logging. Successional patterns of forested cover types used for the update are illustrated in Figure 6.1. All other cover types were assumed to be static unless disturbed or altered by logging activity or Project construction.

6.2.3.3 Evaluation Species

Evaluation species were selected for the HEP update based on the following criteria:

a) Include species that find primary habitat in the four priority cover types (old-growth, mature riparian, wetland and young riparian);

b) Include generalist species that use multiple cover types and will be sensitive to the general loss of terrestrial habitat resulting from inundation;

c) Include species that find habitat in the predominant new cover type (reservoir);

d) Use species from those listed in the 1982 HEP study done by WDW;

e) Include economically important species;

f) Select species for which there is adequate information on habitat requirements (i.e., published habitat model or reliable information in the literature); and

g) Limit the number of species to 10.

Ten evaluation species were selected (Table 6.3). Eight of the 10 were used in the 1982 HEP. The other two, osprey and mallard, were chosen to represent reservoir habitat. The osprey and mallard both utilize reservoir habitat, but they are not exclusively reservoir species and they could have occurred in the area prior to the Project.

Table 6.3 Evaluation species for the Jackson Project Impact HEP update.

Species	Selection Criteria Satisfied
Black-tailed Deer	a, b, d, e, f
Ruffed Grouse	a, b, d, e, f
Black-capped Chickadee	b, d, f
Pileated Woodpecker	a, d, f
Pine Marten	a, d, f
Douglas Squirrel	a, b, d, f
Mallard	a, c, e, f
Common Merganser	c, d, f
Beaver	a, c, d, f
Osprey	c, f

6.2.3.4 Habitat Evaluation

Habitat Suitability Indices (HSIs) were developed for all evaluation species in all cover types where they normally occur (Table 6.4). The HSIs were derived from a number of other sources in the following order of priority:

a) HSIs determined during the 1982 HEP, if they were available;

b) HSIs determined for the same evaluation species in similar cover types in a HEP prepared for the City of Bellevue on the North Fork Snoqualmie River in King County, Washington in 1985 (Beak 1985); and

Table 6.4 Habitat Suitability Indices for the evaluation species used in the Jackson Project Impact HEP update.

Cover Types	Species									
	Black-tailed Deer	Ruffed Grouse	Black-capped Chickadee	Pileated Woodpecker	Pine Marten	Douglas Squirrel	Mallard	Common Merganser	Beaver	Osprey
Reservoir	—	—	—	—	—	—	0.15[2]	0.40[2]	0.30[3]	0.70[2]
Stream/River	—	—	—	—	—	—	0.20[2]	0.61	0.27	0.50[2]
Wetland	0.78	0.50	0.62[1]	0.53	—	—	0.70[2]	0.10[1]	0.78	0.20[2]
Young Riparian Forest	0.70	0.57	0.62[1]	0.40[2]	—	—	0.54[1]	0.30[2]	0.78[2]	—
Mature Riparian Forest	0.70	0.70	0.80[2]	0.80[1]	0.60[2]	0.30[1]	0.10[2]	0.80[2]	0.50[2]	0.50[2]
Young Mixed Forest	0.69	0.43[1]	0.48	0.28[1]	0.40[2]	0.25[1]	—	—	—	—
Mature Coniferous Forest	0.55	0.40[1]	0.60[2]	0.40	0.60[2]	0.80	—	—	—	0.50[2]
Old-growth Coniferous Forest	0.76	0.40[1]	0.70[1]	0.90	0.78	0.80[2]	—	—	—	0.60[2]
Grass/Shrub	0.75[2]	0.45[2]	—	—	—	—	—	—	—	—

HSI values derived from 1982 HEP for the Jackson Project unless otherwise noted.

[1] HSI values derived from HEP study done by WDW, USFWS and BEAK on North Fork Snoqualmie River
[2] HSI values derived from literature and/or experience
[3] Beaver use of reservoirs is limited to within 656 feet of shore

c) review of current literature on the habitat requirements of the evaluation species and comparison with cover type descriptions provided in the 1982 HEP.

The third source relied upon discussion between the District and the agencies, and the professional judgement of all biologists involved to arrive at HSIs that were acceptable to all parties.

Potential HSIs for the HEP update ranged from 0.1 to 1.0 to be consistent with current HEP methodology. HSIs from the 1982 HEP were reported between 1 and 10, so they were divided by 10 for use in the update. The minimum HSI given for any species known to utilize a given cover type was 0.1. The maximum possible was 1.0. No HSI was given if a species was not thought to use the cover type. All HSIs for all species applied to the entire acreage of the cover type in question, except for beaver in the reservoir. Published models indicate that beaver will not use open water beyond 656 feet from the shoreline. Thus, 676 acres of Spada Lake (the area within 656 feet of the shoreline) were rated for beaver under Stage I. Stage II development provided significantly greater shoreline and 1,376 acres of the reservoir were rated for beaver.

In a standard HEP, the habitat value of a given cover type is combined with that of all other cover types to produce HUs for each of the evaluation species. It is difficult, if not impossible, to track the habitat value of a single cover type throughout the HEP unless one of the evaluation species occurs only in that cover type. The 10 evaluation species for the Jackson Project HEP all use two or more cover types, but the WDW and USFWS requested that four of the cover types (old-growth, mature riparian forest, wetland and young riparian forest) be tracked separately so they could be given priority status in mitigation planning. This was accomplished by calculating HUs twice for four of the evaluation species. The first time, HUs were calculated for all cover types used by each respective species. The second time, HUs were determined for each species in a single cover type (i.e., one of the four priority cover types; Table 6.5). Priority cover type evaluation species were identified throughout the HEP with the letter A after the species name.

Table 6.5 Priority cover types and their evaluation species for the Jackson Project Impact HEP update.

Cover Type	Evaluation Species
Old-growth Coniferous Forest	Pine Marten A
Mature Riparian Forest	Ruffed Grouse A
Wetland	Beaver A
Young Riparian Forest	Black-tailed Deer A

6.2.3.5 Period of Analysis and Target Years

The HEP update was run for the 95-year period from 1965 through 2060. This period was believed to represent the life of the Project, and it corresponds to the planning period for the management plan. Key target years within the period of analysis are presented in Table 6.6.

Table 6.6 Target years for the Jackson Project Impact HEP update.

Target Year(s)	Calender Year(s)	Condition
0	1960	Baseline Conditions
1	1965	Stage I Impacts Begin
15	1980	Baseline for Stage II Impacts
20	1985	Stage II Impacts Begin
25-90	1990-2055	Every Five Years
95	2060	Final Target Year

6.2.3.6 Management Assumptions

Several assumptions were made about how the Project lands were managed prior to construction and how they would have been managed if the Project had not been built. These assumptions are:

a) Portions of the forested area inundated by Spada Lake were clearcut prior to 1960 for reasons unrelated to the Project. The baseline (1960) condition for the HEP included 202 acres of young mixed forest and 253 acres of young riparian forest that were the result of earlier logging, as indicated in USFS harvest records on file in Skykomish;

b) All logging that occurred within the Stage II inundation zone (below elevation 1,450 feet MSL) in 1960 or later was attributed to the Project;

c) Four percent of the forest within the inundation zone could not be commercially harvested because of slope and/or soil restrictions and would never have been logged. This included 58 acres of old-growth, 16 acres of mature riparian and 6 acres of mature coniferous forest;

d) Approximately 164 acres of the forest in the inundation zone would have been managed as riparian buffer along the Sultan River and Williamson Creek (assumes 9 miles of stream with 75 feet of buffer zone on each side). These areas would have been logged at a rate of 1 percent per year if the Project had not been built. Riparian buffer zones included 107 acres of old-growth, 10 acres of mature riparian, 21 acres of young mixed forest and 26 acres of young riparian forest in 1960;

e) Commercial timberlands in the inundation zone would have been harvested a second time when they reached 70 years of age according to USFS policy. Once the old-growth and mature cover

types had been logged, there would have been no forest older than 70 years of age except that set aside as non-commercial forest or riparian buffer zone; and

f) All forested lands within the impact area downstream of the reservoir (i.e, pipeline right-of-way, powerhouse site, etc.) would have been managed as commercial timberland on a 60-year rotation. The only exception to this would have been 12 acres of riparian forest that would never have been logged.

The cover type definitions, management assumptions and Project acreages were used to predict the acreage of each cover type in each target year through 2060 with and without the Project (Tables 6.7 and 6.8). These values were used in all future calculations of Habitat Units.

6.2.3.7 Calculations

All calculations were performed according to current HEP procedures (USFWS 1980) using software supplied by the USFWS (USFWS 1985).

6.2.4 Results

The project resulted in a net loss of Average Annual Habitat Units (AAHU) for all species except the mallard, common merganser, osprey and beaver (Table 6.9). The magnitude of loss ranged from 14 AAHUs for the beaver A (wetland priority evaluation species) to 1,054 AAHUs for the black-tailed deer. Gains ranged from 58 AAHUs for the mallard to 854 AAHUs for the osprey. The four priority evaluation species showed a loss of AAHUs. All AAHU calculations are presented in Appendix F.

Table 6.7 Hypothetical distribution of cover types on the Jackson Project impact lands without Project construction.

Target Year	Acres (by Cover Type)								
	Old-growth	Mature Coniferous Forest	Young Mixed Forest	Mature Riparian Forest	Young Riparian Forest	Wetland	Stream/ River	Reservoir	Total Acres
1960	1008.0	212.0	295.0	88.0	258.0	25.0	195.0	0.0	2081.0
1965	913.0	201.0	401.0	81.0	265.0	25.0	195.0	0.0	2081.0
1980	628.0	166.0	721.0	55.0	289.0	27.0	195.0	0.0	2081.0
1985	530.0	98.0	887.0	48.0	296.0	27.0	195.0	0.0	2081.0
1990	435.0	48.0	1032.0	40.0	304.0	27.0	195.0	0.0	2081.0
1995	341.0	38.0	1136.0	33.0	311.0	27.0	195.0	0.0	2081.0
2000	246.0	26.0	1243.0	29.0	315.0	27.0	195.0	0.0	2081.0
2005	152.0	14.0	1349.0	29.0	315.0	27.0	195.0	0.0	2081.0
2010	120.0	6.0	1389.0	28.0	316.0	27.0	195.0	0.0	2081.0
2015	115.0	6.0	1394.0	28.0	316.0	27.0	195.0	0.0	2981.0
2020	110.0	208.0	1197.0	278.0	66.0	27.0	195.0	0.0	2081.0
2025	105.0	314.0	1101.0	286.0	53.0	27.0	195.0	0.0	2081.0
2030	100.0	238.0	1177.0	65.0	279.0	27.0	195.0	0.0	2081.0
2035	95.0	241.0	1179.0	63.0	281.0	27.0	195.0	0.0	2081.0
2040	90.0	310.0	1115.0	67.0	277.0	27.0	195.0	0.0	2081.0
2045	85.0	282.0	1148.0	66.0	278.0	27.0	195.0	0.0	2081.0
2050	80.0	299.0	1136.0	67.0	277.0	27.0	195.0	0.0	2081.0
2055	75.0	290.0	1150.0	66.0	278.0	27.0	195.0	0.0	2081.0
2060	70.0	254.0	1191.0	63.0	281.0	27.0	195.0	0.0	2081.0

Table 6.8 Distribution of cover types on the Jackson Project impact lands with Project construction.

Target Year	Acres (by Cover Type)										
	Old-growth	Mature Coniferous Forest	Young Mixed Forest	Mature Riparian Forest	Young Riparian Forest	Wetland	Stream/ River	Bare Soil	Grass/ Shrub	Reservoir	Total Acres
1960	1008.0	212.0	295.0	85.0	261.0	25.0	195.0	0.0	0.0	0.0	2081.0
1965	708.0	112.0	295.0	7.0	97.0	49.0	63.0	0.0	0.0	750.0	2081.0
1980	508.0	108.0	499.0	7.0	97.0	49.0	63.0	0.0	0.0	750.0	2081.0
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	211.0	0.0	1870.0	2081.0
1990	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
1995	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2000	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2005	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2010	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2015	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2981.0
2020	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2025	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2030	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2035	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2040	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2045	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2050	0.0	87.0	0.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2055	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0
2060	0.0	0.0	87.0	0.0	0.0	0.0	0.0	34.0	90.0	1870.0	2081.0

Table 6.9 Average Annual Habitat Unit (AAHU) changes for the Jackson Project Impact HEP update.

Species	AAHU Without Project	AAHU With Project	Net Change
Black-tailed Deer	1,303	249	-1,054
Ruffed Grouse	859	156	-703
Black-capped Chickadee	1,053	192	-861
Pileated Woodpecker	802	156	-646
Pine Marten	792	152	-640
Douglas Squirrel	650	138	-512
Common Merganser	263	679	+416
Mallard	211	269	+58
Beaver	320	400	+80
Osprey	397	1,251	+854
Black-tailed Deer A	187	13	-174
Ruffed Grouse A	54	1	-53
Pine Marten A	221	84	-137
Beaver A	21	7	-14

6.3 MITIGATION HEP

6.3.1 Background

HEP served two functions in the preparation of the management plan. First, a baseline HEP was performed on the proposed management lands prior to development of the plan to identify habitat features in need of improvement and give direction to the plan. Second, when the plan was complete, HEP was used to evaluate the enhancement measures and estimate their adequacy at offsetting habitat losses identified in the Impact HEP.

The Mitigation HEP was performed between September 1986 and March 1987. It evaluated the management plan that existed as of March 1987 including all management lands proposed for the plan at that time. The plan changed between March and October 1987 due to agency consultations. The land base at Lake Chaplain shifted slightly because of a land exchange between the City and the DNR. Also 182 acres were added to the Lake Chaplain Tract and at least 700 acres may be added to the Spada Lake Tract as a result of agency/co-licensees consultations. The Mitigation HEP was not revised to account for these changes because it was mutually agreed by the agencies and co-licensees that the plan was adequate as described in the settlement offer of October 1987.

6.3.2 Objectives

The objectives of the Mitigation HEP were to: a) guide the preparation of the management plan and b) evaluate the wildlife habitat benefits of the management plan.

6.3.3 Methods

6.3.3.1 Study Area

All lands in the five management tracts as of March 1987 were evaluated in the Mitigation HEP. These included 2,674 acres of forest, shrub, meadow

and road; 88 acres of wetland, 14 acres of natural lake and 2,263 acres of reservoir (Appendix F). Lands acquired by the City in an exchange with the DNR in mid-1987, and lands being considered for acquisition by the District and City in the future were not evaluated in the Mitigation HEP. The locations, management histories and existing conditions of all lands are presented in Chapter 3.0. The five tracts were handled separately throughout study design and field data collection. The Lake Chaplain and Project Facility Lands Tracts were combined during the calculation of HU values; all other tracts were analyzed separately.

6.3.3.2 Cover Types

Existing cover types on all management lands were determined from color aerial photographs taken in 1983 and printed at a scale of 1:12,000. Stereo coverage of the entire study area was interpreted with the aid of a zoom transfer scope and the cover types were plotted on maps, also at a scale of 1:12,000 (Figures 3.2 and 3.12). Forested cover types were ground-truthed on a cursory level by the aerial photo interpreter prior to final mapping. They were ground-truthed in detail by the contract foresters during the timber cruise. Wetlands and non-forested uplands (grass, meadow, etc.) were ground-truthed by a team of wildlife biologists, also prior to final mapping. Lastly, a number of minor changes were made during the HEP field data collection when it was discovered that individual stands were incorrectly mapped. Detailed descriptions of all cover types are presented in Appendix A.

The area of each cover type with and without mitigation was summarized (Tables 6.10 and 6.11 and Appendix F). Future cover types were determined hypothetically from potential management regimes with and without the management plan. Cover types with the management plan were based on the prescriptions in Chapter 3 and the forest successional model presented in Figure 2.2. Cover types without the management plan were derived from existing conditions and/or potential management scenarios without the plan as described in Section 6.3.3.6.

Table 6.10 Hypothetical distribution of cover types on the Jackson Project wildlife habitat management lands without habitat enhancement.

Target Year	Early-Successional Forest	Open Sapling-Pole	Closed Sapling-Pole	Small Sawtimber	Large Sawtimber	Old Growth	Mixed Forest	Deciduous Forest	Mature Riparian Forest	Shrub/Brush
	Acres (by cover type)									
1985	365.8	77.5	38.9	1438.4	9.9	54.5	396.7	52.1	58.6	35.4
1990	782.6	0.0	11.2	1088.4	36.4	54.5	256.2	36.5	49.6	35.4
1995	451.6	365.8	6.8	1046.4	82.8	54.5	256.2	36.5	14.8	35.4
2000	290.1	416.8	365.8	884.8	53.7	31.5	254.1	36.5	14.8	10.7
2005	454.1	34.8	782.6	755.0	53.7	31.5	185.1	36.5	14.8	10.7
2010	719.1	255.3	817.4	399.7	27.2	25.7	80.9	22.8	0.0	10.7
2015	753.9	198.8	706.9	555.6	20.3	25.7	64.1	22.8	0.0	10.7
2020	459.2	520.3	488.9	837.5	3.0	1.6	24.0	13.6	0.0	10.7
2025	238.2	233.6	974.4	872.3	0.0	0.0	19.2	10.4	0.0	10.7
2030	73.9	225.6	952.7	1072.7	0.0	0.0	19.2	4.0	0.0	10.7
2035	148.4	12.6	979.5	1193.7	0.0	0.0	9.9	4.0	0.0	10.7
2040	513.8	61.3	471.8	1297.2	0.0	0.0	0.0	4.0	0.0	10.7
2045	712.8	87.1	299.5	1244.7	0.0	0.0	0.0	4.0	0.0	10.7
2050	541.4	426.7	161.0	1215.0	0.0	0.0	0.0	4.0	0.0	10.7
2055	488.9	286.1	575.1	994.0	0.0	0.0	0.0	4.0	0.0	10.7
2060	753.9	255.3	799.9	535.0	0.0	0.0	0.0	4.0	0.0	10.7

Target Year	Grass/Meadow	Grass/Shrub	Young Mixed Forest	Wetland	Reservoir	Lake	Woodlot	Residential Development	Pasture	TOTAL
	Acres (by cover type)									
1985	24.7	66.0	8.0	87.7	2311.0	14.0	0.0	0.0	0.0	5039.2
1990	24.7	66.0	8.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
1995	24.7	66.0	8.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2000	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2005	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2010	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2015	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2020	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2025	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2030	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2035	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2040	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2045	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2050	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2055	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2
2060	24.7	66.0	0.0	87.7	2311.0	14.0	78.5	20.0	78.5	5039.2

Table 6.11 Distribution of cover types on the Jackson Project wildlife habitat management lands with habitat enhancement.

Target Year	Early-Successional Forest	Open Sapling-Pole	Closed Sapling-Pole	Small Sawtimber	Large Sawtimber (Unthinned)	Large Sawtimber (Thinned)	Old Growth	Mixed Forest	Deciduous Forest	Young Riparian Forest	Mature Riparian Forest
	Acres (by cover type)										
1985	1.9	77.4	34.5	1511.8	28.0	0	328.2	398.0	54.0	50.2	58.0
1990	128.6	77.4	8.5	1369.5	54.2	0	328.2	365.5	54.0	50.2	58.0
1995	223.6	1.9	8.5	1098.1	171.2	56.0	328.2	417.0	54.0	50.2	58.0
2000	223.4	126.7	1.9	954.4	145.2	124.5	328.2	406.2	51.0	50.2	58.0
2005	235.3	223.6	1.9	789.2	155.2	157.1	328.2	395.9	51.0	50.2	58.0
2010	223.6	223.4	128.6	595.8	260.9	138.1	328.2	380.0	51.0	50.2	58.0
2015	219.2	235.3	223.6	298.9	418.4	178.6	328.2	366.2	47.1	50.2	58.0
2020	230.3	223.6	223.4	394.0	436.8	96.9	328.2	322.6	47.1	50.2	58.0
2025	240.4	219.2	235.3	336.0	491.3	85.8	328.2	305.6	47.1	50.2	58.0
2030	278.3	230.3	223.6	379.7	413.7	113.5	328.2	274.5	47.1	50.2	58.0
2035	267.4	240.4	219.2	488.5	340.8	100.6	328.2	266.7	37.1	50.2	58.0
2040	269.7	278.3	230.3	476.6	288.5	171.4	328.2	204.3	37.1	50.2	58.0
2045	293.1	267.4	240.4	484.1	229.4	223.6	328.2	183.4	31.8	50.2	58.0
2050	253.7	269.7	278.3	483.5	240.5	212.3	328.2	183.4	31.8	50.2	58.0
2055	223.6	293.1	267.4	463.2	293.2	224.2	328.2	156.7	31.8	50.2	58.0
2060	249.2	253.7	269.7	512.2	282.1	223.6	328.2	130.9	31.8	50.2	58.0

Target Year	Riparian Buffer	Shrub/ Brush	Grass/ Meadow	Grass/ Shrub	Young Mixed Forest	Wetland	Wetland Buffer	Snag Zone	Reservoir	Lake	Road	TOTAL
	Acres (by cover type)											
1985	0.0	32.1	24.7	67.0	8.0	87.7	0.0	52.0	2211.0	14.0	0.0	5038.5
1990	10.0	32.1	24.7	67.0	8.0	87.7	27.8	52.0	2211.0	14.0	10.1	5038.5
1995	15.0	32.1	41.7	50.0	8.0	96.7	36.2	52.0	2211.0	14.0	15.1	5038.5
2000	28.5	10.7	41.7	50.0	0.0	96.7	37.1	52.0	2211.0	14.0	27.1	5038.5
2005	43.6	10.7	41.7	50.0	0.0	96.7	37.1	52.0	2211.0	14.0	36.1	5038.5
2010	48.4	10.7	41.7	50.0	0.0	96.7	37.1	52.0	2211.0	14.0	39.1	5038.5
2015	53.5	10.7	41.7	50.0	0.0	96.7	37.1	52.0	2211.0	14.0	48.1	5038.5
2020	57.6	10.7	41.7	50.0	0.0	96.7	43.1	52.0	2211.0	14.0	50.6	5038.5
2025	65.6	10.7	41.7	50.0	0.0	96.7	48.1	52.0	2211.0	14.0	51.6	5038.5
2030	65.6	10.7	41.7	50.0	0.0	96.7	48.1	52.0	2211.0	14.0	51.6	5038.5
2035	65.6	10.7	41.7	50.0	0.0	96.7	48.1	52.0	2211.0	14.0	51.6	5038.5
2040	68.6	10.7	41.7	50.0	0.0	96.7	48.1	52.0	2211.0	14.0	53.1	5038.5
2045	69.6	10.7	41.7	50.0	0.0	96.7	48.1	52.0	2211.0	14.0	55.1	5038.5
2050	69.6	10.7	41.7	50.0	0.0	96.7	48.1	52.0	2211.0	14.0	55.1	5038.5
2055	69.6	10.7	41.7	50.0	0.0	96.7	48.1	52.0	2211.0	14.0	55.1	5038.5
2060	69.6	10.7	41.7	50.0	0.0	96.7	48.1	52.0	2211.0	14.0	55.1	5038.5

6.3.3.3 Evaluation Species

The 10 evaluation species selected for the Impact HEP update were used throughout the Mitigation HEP. The process by which the species were selected is discussed in Section 6.2.3.3.

6.3.3.4 Habitat Suitability Index Models

Qualitative word models were developed for all 10 evaluation species. They were derived from a number of sources. The models used in the 1982 Impact HEP (WDG 1982) served as the basis for new models. They were updated to include new and/or regionally-specific information available from USFWS published models, current literature and expert opinions of professional biologists. The new models were reviewed by the District and the agencies, revised as needed, and finalized to the satisfaction of all parties prior to field data collection.

The models followed the general outline of standard USFWS models, with detailed descriptions of food, water, cover, reproduction and general habitat requirements. They were designed specifically for use in qualitative data collection (see Section 6.3.3.7) and contained mathematical formulas and curves for reference only. Literature references were also provided. Copies of all models are included in Appendix F.

6.3.3.5 Period of Analysis and Target Years

The Mitigation HEP was run for the period 1985 through 2060, which is the planning period for the wildlife habitat management plan. The mitigation and enhancement measures described in this management plan will not begin until 1988, but the HEP accounting began in 1985 to show the effect of mitigation measures implemented during construction (i.e., preservation of snags and trees in the upper drawdown zone of Spada Lake; District 1981). The target years included every fifth year from 1985 through 2060, as in the Impact HEP update.

6.3.3.6 Management Assumptions

The fate of the management lands under implementation of the wildlife habitat management plan is described in detail in Chapters 2 and 3. This information was used to determine the condition (i.e, cover type) of each acre in each target year through 2060. Determining the future conditions of the same lands without plan implementation required assumptions about the future management of the lands. Assumptions were made on a tract-by-tract basis, and include:

a) Lake Chaplain Tract: The City of Everett prepared a timber management plan for the tract in 1983 that would have been implemented if the tract was not included in the wildlife habitat management plan (Newman 1983). The Newman plan served as the baseline condition against which future habitat enhancement measures were compared. The key aspects of the Newman plan include clearcut harvest of all forested lands in the tract by 2030, harvest unit sizes in excess of 200 acres, reforestation of harvest units with 300 seedlings per acre, no pre-commercial thinning, no commercial thinning, and clearcut harvest again at a stand age of 65 years in Management Units 1, 2 and 3 and 60 years in Management Units 4, 5 and 6. The Newman plan ended in 2035, so it had to be extended following the same assumptions for use in the HEP;

b) Lost Lake Tract: The owner of the Lost Lake tract planned to divide it into 10 equal sized parcels for suburban residential development surrounding a water ski course on the lake. It was assumed for the HEP that each parcel would contain approximately 2 acres of developed land (house, driveway, road, etc.), 8 acres of pasture or lawn and 8 acres of woodlot. The area of the lake would have remained the same, but its value to wildlife would have been greatly diminished;

c) Project Facility Lands Tract: It was assumed that this tract would have been maintained permanently in low-growing vegetation (grass and shrubs). There would have been regular maintenance to control tall-growing woody vegetation;

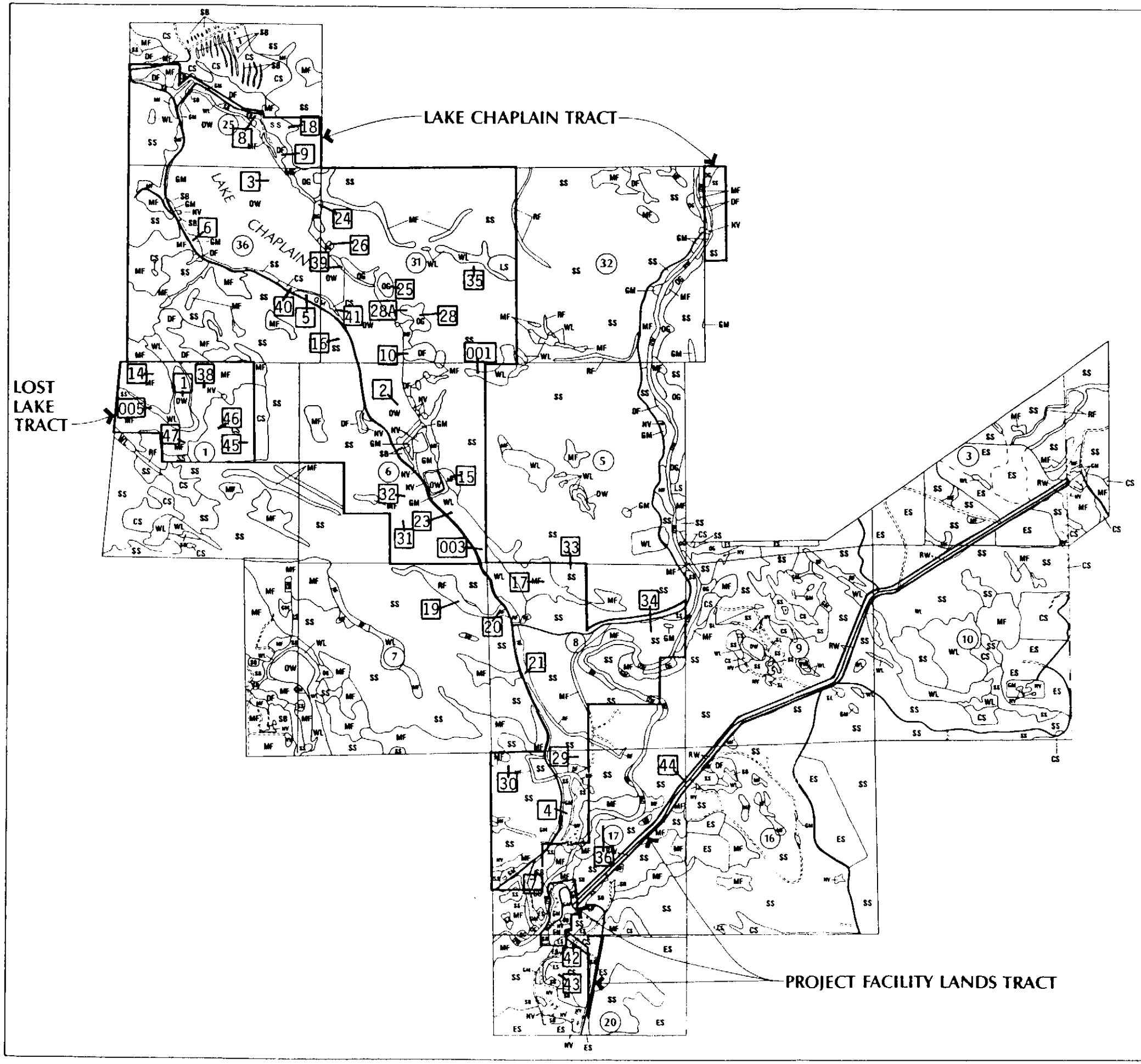
d) Spada Lake Tract: Spada Lake would have been entirely clearcut logged (up to elevation 1,450 feet MSL), with no attempt at re-vegetation of the drawdown zone. The shoreline forest would have been managed as commercial timberland; and

e) Williamson Creek Tract: All old-growth forest in the Williamson Creek Tract would have been clearcut by the DNR by 1985. The mature riparian forest would have been clearcut by 1990, and the mixed forest would have been clearcut by 2015. All lands would have been retained in commercial timber production and harvested again after 60 years.

6.3.3.7 Sampling Design and Field Data Collection

Field evaluation of the existing cover types was performed at 59 randomly selected points (Figures 6.2 and 6.3). All cover types in all tracts were evaluated. The number of evaluation points in each cover type varied from one to six, depending on the area and homogeneity of the cover type. Small, homogeneous cover types were evaluated at as few as one point, while large, variable cover types, such as small sawtimber coniferous forest, were evaluated at as many as six points.

Evaluation points were selected by placing a line grid over the cover type map and randomly selecting coordinates. The cover type map was then superimposed over the timber cruise map prepared by the forester, and the timber cruise station nearest each selected coordinate became the HEP evaluation point. This helped field crews find the evaluation points because all timber cruise stations were flagged in the field during the cruise. It will also facilitate future comparison of timber data and HEP results, if desirable. Evaluation point selection continued until the



LEGEND

- All-Weather Road
- Dirt Road or Unmaintained Gravel Road
- (8) Section Number [5] Sampling Point

COVER TYPES

- ES Early Successional Forest
- OS Open Canopy Sapling/Pole Coniferous Forest
- CS Closed Canopy Sapling/Pole Coniferous Forest
- SS Small Sawtimber Coniferous Forest
- LS Large Sawtimber Coniferous Forest
- OG Old-growth Coniferous Forest
- MF Mixed Deciduous/Coniferous Forest
- DF Deciduous Forest
- RF Riparian Forest
- SB Mixed Shrub/Brush
- GM Grass/Meadow
- WL Wetland
- OW Open Water
- NV Non-Vegetated
- SL Slides
- RW Right-Of-Way

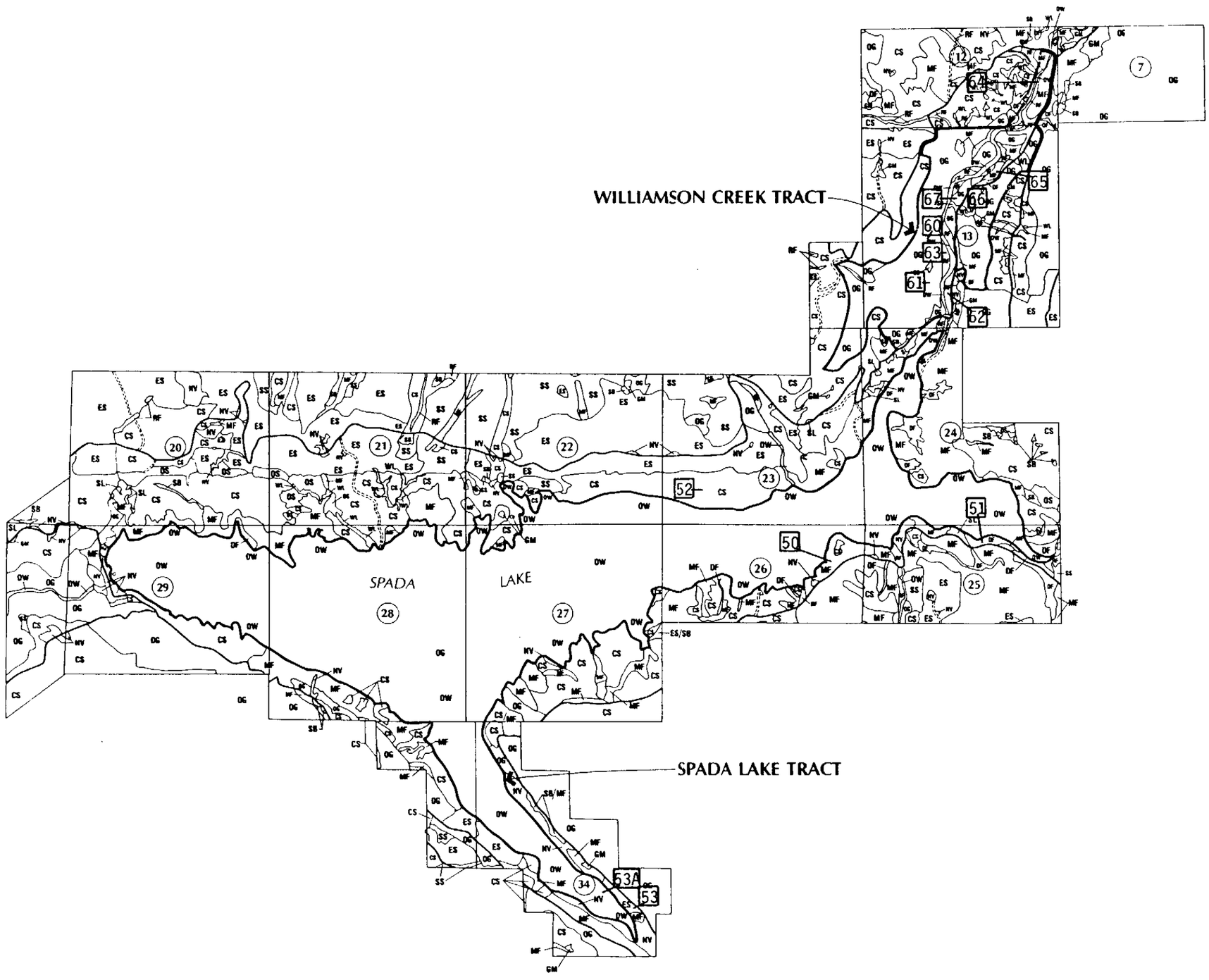
NORTH

0 1000 2000 4000
SCALE IN FEET

HENRY M. JACKSON PROJECT FERC NO. 2157
PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY
AND THE CITY OF EVERETT, WASHINGTON

WILDLIFE HABITAT MANAGEMENT PLAN

Figure 6.2 Data collection points for the Mitigation HEP at the Lake Chaplain, Lost Lake and Project Facility Lands Tracts.



LEGEND

COVER TYPES

- ES Early Successional Forest
- OS Open-Canopy Sapling/Pole Coniferous Forest
- CS Closed-Canopy Sapling/Pole Coniferous Forest
- SS Small Sawtimber Coniferous Forest
- LS Large Sawtimber Coniferous Forest
- OG Old-growth Coniferous Forest
- MF Mixed Deciduous/Coniferous Forest
- DF Deciduous Forest
- RF Riparian Forest
- SB Mixed Shrub/Brush
- GM Grass/Meadow
- WL Wetland
- OW Open Water
- NV Non-Vegetated
- SL Slides

——— All Weather Road

- - - - - - Dirt Road or Unmaintained Gravel Road

(7) Section Number [5] Sampling Point

NORTH

0 1000 2000 3000
SCALE IN FEET

HENRY M. JACKSON PROJECT FERC NO. 2157
PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY
AND THE CITY OF EVERETT, WASHINGTON

WILDLIFE HABITAT MANAGEMENT PLAN

Figure 6.3 Data collection points for the Mitigation HEP at the Spada Lake and Williamson Creek Tracts.

desired number of points were chosen in each cover type.

Each evaluation point was visited by a team made up of a District representative and one or more biologists from the consultant (the agencies declined to participate in field evaluation, but attended a one-day review in the field at the end of the collection period). At each point the team began by taking descriptive notes (i.e., density, height and species of trees and shrubs, topography, presence of special habitat features, signs of animal use, etc.) and photographs of the habitat. They then reviewed the HSI models and completed an evaluation form for each species. The form required them to identify the presence or absence of each species life requirements, as well as potential methods of improving the habitat for the species. The final step was the assignment of HSIs between 0.1 and 1.0 for each species. Each team member developed their score independently, and the team then discussed differences until a mutually agreeable score was found. The team developed two HSIs for each species at each evaluation point; one for existing conditions and one to represent future potential with the implementation of recommended enhancement measures.

6.3.3.8 Calculations

All calculations were performed according to standard HEP procedures (USFWS 1980), but a Lotus 1-2-3 spreadsheet (version 2.0) was used in place of the HEP software. This was done to: a) increase the number of target years from 14 (the maximum allowable with HEP software) to 19, b) increase the speed of calculations and c) provide a full spreadsheet for each evaluation species showing habitat values in each cover type in each target year rather than the single number summary produced by HEP software.

6.3.4 Results

The management plan provided a net increase in AAHUs for all 10 of the evaluation species (Table 6.12). The greatest increases were realized for the pileated woodpecker (892 AAHUs), black-tailed deer (730 AAHUs) and pine marten (709 AAHUs). Net increases were also provided for the four priority

cover type evaluation species. Pine marten A, the old-growth priority evaluation species, received the greatest benefit of the four priority species.

Table 6.12 Average Annual Habitat Unit (AAHU) changes for the Jackson Project Mitigation HEP (as of March 1987).

	AAHU		
Species	Without Mgmt. Plan	With Mgmt. Plan	Net Change
Black-tailed Deer	1,132	1,862	+730
Ruffed Grouse	596	1,170	+574
Black-capped Chickadee	830	1,310	+480
Pileated Woodpecker	631	1,523	+892
Pine Marten	573	1,282	+709
Douglas Squirrel	826	1,436	+610
Common Merganser	972	1,045	+ 73
Mallard	472	569	+ 97
Beaver	763	840	+ 77
Osprey	1,696	2,165	+469
Black-tailed Deer A	0	23	+ 23
Ruffed Grouse A	13	45	+ 32
Pine Marten A	14	294	+280
Beaver A	70	90	+ 20

Changes made in the management plan between March and December 1987 resulted in an increase in the amount of mixed forest, a decrease in the amount of 60-year rotation coniferous forest and elimination of some of the enhancement measures for species that benefited from the creation of the Spada Lake reservoir. A rough estimate of the HEP benefits from the changes in the Lake Chaplain Tract would include increases in AAHUs of about 10 to 20 percent for the black-tailed deer, ruffed grouse and black-capped chickadee; increases of less than 10 percent for the pine marten and Douglas squirrel and decreases for the water related species (mallard, common merganser, osprey and beaver). The addition of at least 700 acres of land near Spada Lake will significantly increase the AAHUs even more for all evaluation species.

6.4 MITIGATION ANALYSIS

The results of the Impact HEP Update and the Mitigation HEP are compared in Table 6.13. Full mitigation or more is provided for seven of the 10 evaluation species and two of the four priority cover type evaluation species. The late-successional species (pine marten, pileated woodpecker and Douglas squirrel) received at least 110 percent mitigation. Three species (black-tailed deer, ruffed grouse and black-capped chickadee) were mitigated less than 100 percent because of the emphasis on late-successional coniferous forest in the management plan. The changes in the plan for the Lake Chaplain Tract made after the HEP analysis provided more mixed forest for these three species and increased the amount of mitigation achieved. The addition of at least 700 acres near Spada Lake also would increase significantly the mitigation for these three species. The overall adequacy of mitigation ultimately was determined through consultation with the resource agencies.

Table 6.13 Comparison of Average Annual Habitat Unit (AAHU) changes from the Jackson Project HEP assessments.

	AAHU		
Species	Net Change from Impact HEP	Net Change From Mitigation HEP[1]	% Mitigation
Black-tailed Deer	-1,054	+730	69%
Ruffed Grouse	- 703	+574	82%
Black-capped Chickadee	- 861	+480	56%
Pileated Woodpecker	- 646	+892	138%
Pine Marten	- 640	+709	111%
Douglas Squirrel	- 512	+610	119%
Common Merganser	+ 416	+ 73	+
Mallard	+ 58	+ 97	+
Beaver	+ 80	+ 77	+
Osprey	+ 854	+469	+
Black-tailed Deer A	- 174	+ 23	13%
Ruffed Grouse A	- 53	+ 32	60%
Pine Marten A	- 137	+280	204%
Beaver A	- 14	+ 20	143%

[1]As of March 1987, prior to the addition of 182 acres to the Lake Chaplain Tract and at least 700 acres to the Spada Lake Tract.

7.0 ECONOMIC ANALYSIS

7.1 INTRODUCTION

Mitigation costs were estimated for all management tracts over the life of the plan (1988 through 2060). Costs were divided into three major categories; land acquisition, wildlife habitat enhancement and forest management. Land acquisition costs will be those costs associated with the purchase of management tracts. Wildlife habitat enhancement costs will include labor, materials, equipment and contract services required to implement, maintain and monitor the enhancement measures described in the plan. Forest management costs will be all costs of growing, managing and harvesting trees under the prescriptions presented in the plan. Forest management costs will include all decreases in timber revenues (opportunity costs) associated with the delay or elimination of timber harvest in forested stands. All costs reported in this chapter are stated in 1987 dollars.

7.2 LAND ACQUISITION

The Lost Lake and Williamson Creek tracts will be purchased specifically for wildlife habitat management. Total purchase cost for the two parcels is estimated to be $1,481,224 (Table 7.1). Costs to be incurred in the acquisition of at least 700 acres near Spada Lake are not included in Table 7.1.

Table 7.1 Land acquisition costs for the Jackson Project wildlife habitat management plan.

Tract	Cost
Lost Lake	$ 424,476.00
Williamson Creek	$1,056,748.00[1]
TOTAL	$1,481,224.00

[1] Estimated cost, subject to final negotiations

7.3 WILDLIFE HABITAT ENHANCEMENT

Habitat enhancement costs were separated into the three major areas of activity described in the plan; implementation, maintenance and monitoring. Implementation will involve the initiation of habitat enhancement programs and the construction or placement of specific habitat structures such as nest boxes. Implementation will take place from 1988 through 1995. Maintenance costs will result from the continuation of programs begun during the implementation phase and the up-keep, repair and replacement of structures. Maintenance will occur in all years through 2060. Monitoring will be conducted to verify the successful completion of initiation and maintenance, and it will also occur in all years through 2060.

Enhancement costs were calculated for each individual element (e.g., nest boxes, snags, forage enhancement, etc.) by determining the materials and labor required to complete the element. Standard labor and equipment rates were used throughout (Table 7.2). Material costs were determined for specific elements by obtaining telephone quotes from local suppliers or from recent experience with similar mitigation efforts.

The costs of wildlife habitat enhancement in the five tracts are shown in Tables 7.3 through 7.7. The total cost estimate is $3,428,707 (Table 7.8).

Table 7.2 Charge rates for the major cost items of wildlife habitat enhancement; in 1987 dollars.

Item	Rate
District Biologist	$25.00/hour
District Clerical	$15.00/hour
Contract Biologist	$25.00/hour
Contract Laborer	$23.00/hour
Snag Creation	$40.00/snag
Four-wheel Drive Vehicle	$ 0.50/mile
Boat	$20.00/day

Table 7.3 Wildlife habitat enhancement costs for the Lake Chaplain Tract (in 1987 dollars).

	Period															
	1986 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	2041 to 2045	2046 to 2050	2051 to 2055	2056 to 2060	TOTAL
IMPLEMENTATION																
MATERIALS	$12,290	$5,410	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$12,240	$17,063	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
CONTRACT LABOR	$72,393	$113,511	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
EQUIPMENT	$5,865	$8,132	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
SUBTOTAL	$102,788	$144,116	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$246,904
MAINTENANCE																
MATERIALS	$300	$300	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	
DISTRICT LABOR	$32,704	$32,704	$42,136	$42,136	$42,136	$42,136	$42,136	$42,136	$42,136	$42,136	$42,136	$42,136	$42,136	$42,136	$42,136	
CONTRACT LABOR	$11,625	$11,625	$41,075	$41,075	$41,075	$41,075	$41,075	$41,075	$41,075	$41,075	$41,075	$41,075	$41,075	$41,075	$41,075	
EQUIPMENT	$6,050	$6,050	$8,300	$8,300	$8,300	$8,300	$8,300	$8,300	$8,300	$8,300	$8,300	$8,300	$8,300	$8,300	$8,300	
SUBTOTAL	$50,679	$50,679	$100,511	$100,511	$100,511	$100,511	$100,511	$100,511	$100,511	$100,511	$100,511	$100,511	$100,511	$100,511	$100,511	$1,408,001
MONITORING																
MATERIALS	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	
DISTRICT LABOR	$7,560	$5,964	$12,936	$11,340	$12,936	$11,340	$12,936	$11,340	$12,936	$11,340	$12,936	$11,340	$12,936	$11,340	$12,936	
CONTRACT LABOR	$28,950	$16,050	$33,150	$20,250	$33,150	$20,250	$33,150	$20,250	$33,150	$20,250	$33,150	$20,250	$33,150	$20,250	$33,150	
EQUIPMENT	$3,700	$2,250	$4,700	$3,250	$4,700	$3,250	$4,700	$3,250	$4,700	$3,250	$4,700	$3,250	$4,700	$3,250	$4,700	
SUBTOTAL	$41,210	$25,264	$51,786	$35,840	$51,786	$35,840	$51,786	$35,840	$51,786	$35,840	$51,786	$35,840	$51,786	$35,840	$51,786	$644,016
TOTAL	$194,677	$220,059	$152,297	$136,351	$152,297	$136,351	$152,297	$136,351	$152,297	$136,351	$152,297	$136,351	$152,297	$136,351	$152,297	$2,298,921

Table 7.4 Wildlife habitat enhancement costs for the Lost Lake Tract (in 1987 dollars).

	Period															
	1986 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	2041 to 2045	2046 to 2050	2051 to 2055	2056 to 2060	TOTAL
IMPLEMENTATION																
MATERIALS	$1,248	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$11,321	$9,040	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
CONTRACT LABOR	$19,222	$2,250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
EQUIPMENT	$2,509	$500	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
SUBTOTAL	$34,300	$11,790	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$46,090
MAINTENANCE																
MATERIALS	$0	$473	$1,323	$473	$473	$473	$1,328	$1,328	$1,328	$473	$1,328	$1,328	$1,328	$473	$1,328	
DISTRICT LABOR	$0	$756	$21,528	$7,556	$7,668	$7,556	$21,528	$7,864	$21,528	$7,556	$21,528	$21,416	$21,528	$7,556	$21,528	
CONTRACT LABOR	$0	$6,025	$14,198	$6,025	$9,405	$6,025	$14,197	$9,597	$14,198	$6,025	$14,198	$10,817	$14,198	$6,025	$14,197	
EQUIPMENT	$0	$840	$3,576	$840	$1,040	$840	$3,576	$1,126	$3,576	$840	$3,576	$3,376	$3,576	$840	$3,576	
SUBTOTAL	$0	$8,094	$40,625	$14,894	$18,586	$14,894	$40,629	$19,915	$40,630	$14,894	$40,630	$36,937	$40,630	$14,894	$40,629	$386,881
MONITORING																
MATERIALS																
DISTRICT LABOR	$140	$700	$4,830	$4,690	$4,830	$4,690	$4,830	$4,690	$4,830	$4,690	$4,830	$4,690	$4,830	$4,690	$4,830	
CONTRACT LABOR	$1,100	$5,625	$15,163	$14,063	$15,163	$14,063	$15,163	$14,063	$15,163	$14,063	$15,163	$14,063	$15,163	$14,063	$15,163	
EQUIPMENT	$150	$1,450	$2,850	$2,700	$2,850	$2,700	$2,850	$2,700	$2,850	$2,700	$2,850	$2,700	$2,850	$2,700	$2,850	
SUBTOTAL	$1,390	$7,775	$22,843	$21,453	$22,843	$21,453	$22,843	$21,453	$22,843	$21,453	$22,843	$21,453	$22,843	$21,453	$22,843	$297,784
TOTAL	$35,690	$27,659	$63,468	$36,347	$41,429	$36,347	$63,472	$41,368	$63,473	$36,347	$63,473	$58,390	$63,473	$36,347	$63,472	$730,755

Table 7.5 Wildlife habitat enhancement costs for the Project Facility Lands Tract (in 1987 dollars).

	Period															
	1986 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	2041 to 2045	2046 to 2050	2051 to 2055	2056 to 2060	TOTALS
IMPLEMENTATION																
MATERIALS	$12,031	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$2,464	$2,240	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
CONTRACT LABOR	$9,865	$1,125	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
EQUIPMENT	$1,300	$250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
SUBTOTAL	$25,660	$3,615	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$29,275
MAINTENANCE																
MATERIALS	$3,140	$3,140	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$672	$672	$784	$784	$784	$812	$812	$784	$812	$784	$812	$784	$812	$784	$812	
CONTRACT LABOR	$2,640	$2,640	$0	$0	$0	$2,065	$2,065	$0	$2,065	$0	$2,065	$0	$2,065	$0	$2,065	
EQUIPMENT	$450	$300	$0	$0	$0	$50	$50	$0	$50	$0	$50	$0	$50	$0	$50	
SUBTOTAL	$6,902	$6,752	$784	$784	$784	$2,927	$2,927	$784	$2,927	$784	$2,927	$784	$2,927	$784	$2,927	$36,704
MONITORING																
MATERIALS																
DISTRICT LABOR	$1,054	$850	$1,568	$1,568	$1,568	$1,568	$1,568	$1,568	$1,568	$1,568	$1,568	$1,568	$1,568	$1,568	$1,568	
CONTRACT LABOR	$2,700	$1,800	$1,125	$1,125	$1,125	$1,125	$1,125	$1,125	$1,125	$1,125	$1,125	$1,125	$1,125	$1,125	$1,125	
EQUIPMENT	$400	$300	$350	$350	$350	$350	$350	$350	$350	$350	$350	$350	$350	$350	$350	
SUBTOTAL	$4,154	$2,950	$3,043	$3,043	$3,043	$3,043	$3,043	$3,043	$3,043	$3,043	$3,043	$3,043	$3,043	$3,043	$3,043	$46,663
TOTAL	$36,716	$13,317	$3,827	$3,827	$3,827	$5,970	$5,970	$3,827	$5,970	$3,827	$5,970	$3,827	$5,970	$3,827	$5,970	$112,642

Table 7.6 Wildlife habitat enhancement costs for the Spada Lake Tract (in 1987 dollars).

	Period															
IMPLEMENTATION	1986 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	2041 to 2045	2046 to 2050	2051 to 2055	2056 to 2060	TOTAL
MATERIALS	$1,855	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$4,032	$3,360	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
CONTRACT LABOR	$6,129	$2,250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
EQUIPMENT	$1,090	$500	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
SUBTOTAL	$13,106	$6,110	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$19,216
MAINTENANCE																
MATERIALS	$430	$430	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$1,120	$1,120	$784	$784	$1,064	$784	$863	$784	$862	$784	$863	$784	$862	$784	$863	
CONTRACT LABOR	$430	$430	$0	$0	$7,690	$0	$1,750	$0	$1,750	$0	$1,750	$0	$1,750	$0	$1,750	
EQUIPMENT	$250	$250	$0	$0	$500	$0	$140	$0	$140	$0	$140	$0	$140	$0	$140	
SUBTOTAL	$2,230	$2,230	$784	$784	$9,254	$784	$2,753	$784	$2,752	$784	$2,753	$784	$2,752	$784	$2,753	$32,965
MONITORING																
MATERIALS																
DISTRICT LABOR	$0	$1,400	$3,640	$2,520	$2,604	$2,520	$2,604	$2,520	$2,604	$2,520	$2,604	$2,520	$2,604	$2,520	$2,604	
CONTRACT LABOR	$0	$7,850	$10,100	$4,500	$5,150	$4,500	$5,150	$4,500	$5,150	$4,500	$5,150	$4,500	$5,150	$4,500	$5,150	
EQUIPMENT	$0	$1,250	$1,750	$750	$850	$750	$850	$750	$850	$750	$850	$750	$850	$750	$850	
SUBTOTAL	$0	$10,500	$15,490	$7,770	$8,604	$7,770	$8,604	$7,770	$8,604	$7,770	$8,604	$7,770	$8,604	$7,770	$8,604	$124,234
TOTAL	$15,336	$18,840	$16,274	$8,554	$17,858	$8,554	$11,357	$8,554	$11,356	$8,554	$11,357	$8,554	$11,356	$8,554	$11,357	$176,415

Table 7.7 Wildlife habitat enhancement costs for the Williamson Creek Tract (in 1987 dollars).

	Period															
	1986 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	2041 to 2045	2046 to 2050	2051 to 2055	2056 to 2060	TOTAL
IMPLEMENTATION																
MATERIALS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$2,256	$3,360	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
CONTRACT LABOR	$8,610	$2,250	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
EQUIPMENT	$742	$500	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
SUBTOTAL	$11,608	$6,110	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$17,718
MAINTENANCE																
MATERIALS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$0	$0	$840	$784	$840	$784	$840	$784	$840	$784	$840	$784	$840	$784	$840	
CONTRACT LABOR	$0	$0	$1,490	$0	$1,490	$0	$1,490	$0	$1,490	$0	$1,490	$0	$1,490	$0	$1,490	
EQUIPMENT	$0	$0	$100	$0	$100	$0	$100	$0	$100	$0	$100	$0	$100	$0	$100	
SUBTOTAL	$0	$0	$2,430	$784	$2,430	$784	$2,430	$784	$2,430	$784	$2,430	$784	$2,430	$784	$2,430	$21,714
MONITORING																
MATERIALS																
DISTRICT LABOR	$84	$0	$2,324	$2,240	$2,324	$2,240	$2,324	$2,240	$2,324	$2,240	$2,324	$2,240	$2,324	$2,240	$2,324	
CONTRACT LABOR	$575	$0	$2,825	$2,250	$2,825	$2,250	$2,825	$2,250	$2,825	$2,250	$2,825	$2,250	$2,825	$2,250	$2,825	
EQUIPMENT	$50	$0	$550	$500	$550	$500	$550	$500	$550	$500	$550	$500	$550	$500	$550	
SUBTOTAL	$709	$0	$5,699	$4,990	$5,699	$4,990	$5,699	$4,990	$5,699	$4,990	$5,699	$4,990	$5,699	$4,990	$5,699	$70,542
TOTAL	$12,317	$6,110	$8,129	$5,774	$8,129	$5,774	$8,129	$5,774	$8,129	$5,774	$8,129	$5,774	$8,129	$5,774	$8,129	$109,974

Table 7.8 Summary of wildlife habitat enhancement costs for the Jackson Project wildlife habitat management plan (in 1987 dollars).

	Period															
IMPLEMENTATION	1986 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	2041 to 2045	2046 to 2050	2051 to 2055	2056 to 2060	TOTAL
MATERIALS	$27,424	$5,410	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
DISTRICT LABOR	$32,313	$35,063	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
CONTRACT LABOR	$116,219	$121,386	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
EQUIPMENT	$11,506	$9,882	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
SUBTOTAL	$187,462	$171,741	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$359,203
MAINTENANCE																
MATERIALS	$3,870	$4,343	$10,323	$9,473	$9,473	$9,473	$10,328	$10,328	$10,328	$9,473	$10,328	$10,328	$10,328	$9,473	$10,328	
DISTRICT LABOR	$34,496	$35,252	$66,072	$52,044	$52,492	$52,072	$66,179	$52,352	$66,178	$52,044	$66,179	$65,904	$66,178	$52,044	$66,179	
CONTRACT LABOR	$14,695	$20,720	$56,763	$47,100	$59,660	$49,165	$60,577	$50,672	$60,578	$47,100	$60,578	$51,892	$60,578	$47,100	$60,577	
EQUIPMENT	$6,750	$7,440	$11,976	$9,140	$9,940	$9,190	$12,166	$9,426	$12,166	$9,140	$12,166	$11,676	$12,166	$9,140	$12,166	
SUBTOTAL	$59,811	$67,755	$145,134	$117,757	$131,565	$119,900	$149,250	$122,778	$149,250	$117,757	$149,251	$139,800	$149,250	$117,757	$149,250	$1,886,265
MONITORING																
MATERIALS	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	
DISTRICT LABOR	$8,838	$8,914	$25,298	$22,358	$24,262	$22,358	$24,262	$22,358	$24,262	$22,358	$24,262	$22,358	$24,262	$22,358	$24,262	
CONTRACT LABOR	$33,325	$31,325	$62,363	$42,188	$57,413	$42,188	$57,413	$42,188	$57,413	$42,188	$57,413	$42,188	$57,413	$42,188	$57,413	
EQUIPMENT	$4,300	$5,250	$10,200	$7,550	$9,300	$7,550	$9,300	$7,550	$9,300	$7,550	$9,300	$7,550	$9,300	$7,550	$9,300	
SUBTOTAL	$47,463	$46,489	$98,861	$73,096	$91,975	$73,096	$91,975	$73,096	$91,975	$73,096	$91,975	$73,096	$91,975	$73,096	$91,975	$1,183,239
TOTAL	$294,736	$285,985	$243,995	$190,853	$223,540	$192,996	$241,225	$195,874	$241,225	$190,853	$241,226	$212,896	$241,225	$190,853	$241,225	$3,428,707

7.4 FOREST LAND MANAGEMENT

Forest management costs will be incurred for the Lake Chaplain and Lost Lake Tracts. Decreased harvest unit size, modified harvest techniques and intensive management of forest stands will increase administration costs. Protection (no-harvest) of some stands and delayed harvest of others will decrease forest labor, materials and harvest costs but will also decrease net timber revenues. The result is the overall costs of managing the forests will increase with implementation of the wildlife plan.

All costs and revenue losses for the Lake Chaplain Tract were calculated by comparing projected costs and revenues under the wildlife management plan to similar parameters under the forest management plan prepared by the City (Newman 1983). Administration costs under the wildlife plan will be less than under the Newman plan in some years but more in other years. Overall administration costs will be $660,993 greater under the wildlife plan (Table 7.9). Timber revenues will follow a similar pattern; they will be greater in some years under the wildlife plan but overall they will be $3,414,481 less than the City would realize under the Newman plan. Revenue losses will be off-set partially by decreases in labor, materials and harvest costs of $1,764,441. Net forest management costs (including revenue losses) for the Lake Chaplain Tract will be $2,311,033.

Forest management costs for the Lost Lake Tract will be the costs of managing the tract according to the wildlife management plan. There is no alternative plan for comparison, as the District would not have purchased the land if it were not needed for wildlife management. The Lost Lake Tract will return a net profit of $459,552 during the 73 years of the management plan (when the cost of land acquisition is not considered; Table 7.10). When the cost of the land is deducted from forest revenues, the tract will return approximately $35,000.

Table 7.9 Forest management costs for the Lake Chaplain Tract; in 1987 dollars. (Numbers in parentheses are net savings or revenue gains).

	Costs (Savings)					
Period	Admin.	Forest Labor	Materials	Harvest Costs	Revenue Losses	Total
1981-1985	(15,189)	(8,000)	(4,110)	(332,585)	839,779	479,895
1986-1990	28,829	(2,690)	(3,565)	43,720	454,154	520,448
1991-1995	61,827	(1,254)	6,600	734,372	(1,383,795)	(582,250)
1996-2000	29,203	(12,672)	(7,091)	(860,115)	1,883,950	1,033,275
2001-2005	16,427	(22,974)	(12,708)	(1,933,655)	4,405,097	2,452,187
2006-2010	(33,770)	(43,054)	(26,270)	(3,663,604)	8,569,223	4,802,525
2011-2015	23,644	(49,868)	(5,358)	(516,225)	1,019,938	472,131
2016-2020	28,323	(17,948)	(3,522)	(583,357)	1,385,533	809,029
2021-2025	63,065	(2,371)	7,288	1,156,435	(2,908,946)	(1,684,529)
2026-2030	49,333	17,685	8,063	769,029	(2,201,781)	(1,357,671)
2031-2035	75,736	11,516	6,785	1,108,663	(2,825,089)	(1,622,389)
2036-2040	85,968	11,270	8,441	1,202,842	(3,030,840)	(1,722,319)
2041-2045	63,985	5,503	3,497	514,722	(1,137,665)	(549,958)
2046-2050	72,454	12,441	7,466	695,087	(1,855,347)	(1,067,899)
2051-2055	43,116	(13,593)	(4,604)	(571,990)	1,743,721	1,196,650
2056-2060	68,042	9,358	5,832	592,127	(1,543,451)	(868,092)
TOTAL	660,993	(106,651)	(13,256)	(1,644,534)	3,414,481	$2,311,033

Table 7.10 Forest management costs for the Lost Lake Tract; in 1987 dollars. (Numbers in parentheses are net savings or revenue gains).

	Costs (Savings)					
Period	Admin.	Forest Labor	Materials	Harvest Costs	Revenue Losses	Total
1981-1985	0	0	0	0	0	0
1986-1990	0	0	0	0	0	0
1991-1995	0	0	0	0	0	0
1996-2000	9,766	1,400	1,017	83,299	(105,306)	(9,814)
2001-2005	1,200	685	0	0	0	1,885
2006-2010	1,600	0	0	455	0	2,055
2011-2015	0	0	0	0	0	0
2016-2020	8,756	1,300	952	72,938	(144,332)	(60,386)
2021-2025	7,455	634	0	27,256	(31,944)	3,401
2026-2030	10,006	1,500	1,080	50,438	(94,535)	(31,511)
2031-2035	1,200	731	0	0	0	1,931
2036-2040	18,412	3,000	2,162	173,260	(393,888)	(197,054)
2041-2045	2,400	1,463	0	0	0	3,863
2046-2050	11,406	1,300	952	44,888	(103,612)	(45,066)
2051-2055	1,200	634	0	0	0	1,834
2056-2060	13,509	1,900	1,397	83,834	(231,330)	(130,690)
TOTAL	86,920	14,547	7,560	536,638	(1,104,947)	$(459,552)

7.5 SUMMARY

Total costs of the wildlife habitat management plan, excluding plan development costs, will be $6,761,412 over the 73 years of the plan. Costs per tract are summarized in Tables 7.11 through 7.15, and a summary of all tracts appears in Table 7.16.

Table 7.11 Summary of wildlife management costs for the Lake Chaplain Tract; in 1987 dollars. (Numbers in parentheses are net savings or revenue gains).

	Costs			
Period	Land Acquisition	Habitat Enhancement	Forest Management	Total
1981-1985	0	0	479,895	479,895
1986-1990	0	194,677	520,448	715,125
1991-1995	0	220,059	(582,250)	(362,191)
1996-2000	0	152,297	1,033,275	1,185,572
2001-2005	0	136,351	2,454,187	2,590,538
2006-2010	0	152,297	4,802,525	4,954,822
2011-2015	0	136,351	472,131	608,482
2016-2020	0	152,297	809,029	961,326
2021-2025	0	136,351	(1,684,529)	(1,548,178)
2026-2030	0	152,297	(1,357,671)	(1,205,374)
2031-2035	0	136,351	(1,622,389)	(1,486,038)
2036-2040	0	152,297	(1,722,319)	(1,570,022)
2041-2045	0	136,351	(549,958)	(413,607)
2046-2050	0	152,297	(1,067,899)	(915,602)
2051-2055	0	136,351	1,196,650	(1,333,001)
2056-2060		152,297	(868,092)	715,795
TOTAL	0	2,298,921	2,311,033	$4,609,954

Table 7.12 Summary of wildlife management costs for the Lost Lake Tract; in 1987 dollars. (Numbers in parentheses are net savings or revenue gains).

	Costs (Savings)			
Period	Land Acquisition	Habitat Enhancement	Forest Management	Total
1986-1990	424,476	35,690	0	460,166
1991-1995	0	27,659	0	27,659
1996-2000	0	63,468	(9,814)	53,654
2001-2005	0	36,347	1,185	38,232
2006-2010	0	41,429	2,055	43,484
2011-2015	0	36,347	0	36,347
2016-2020	0	63,472	(60,386)	3,086
2021-2025	0	41,368	3,401	44,769
2026-2030	0	63,473	(31,511)	31,962
2031-2035	0	41,368	1,931	38,278
2036-2040	0	63,473	(197,054)	(133,581)
2041-2045	0	58,390	3,863	62,253
2046-2050	0	63,473	(45,066)	18,407
2051-2055	0	36,347	1,834	38,181
2056-2060	0	63,472	(130,690)	(67,218)
TOTAL	424,476	730,755	(459,552)	$695,679

Table 7.13 Summary of wildlife management costs for the Project Facility Lands Tract; in 1987 dollars.

Period	Habitat Enhancement Costs
1986-1990	36,716
1991-1995	13,317
1996-2000	3,827
2001-2005	3,827
2006-2010	3,817
2011-2015	5,970
2016-2020	5,970
2021-2025	3,827
2026-2030	5,970
2031-2035	3,827
2036-2040	5,970
2041-2045	3,827
2046-2050	5,970
2051-2055	3,827
2056-2060	5,970
TOTAL	$112,642

Table 7.14 Summary of wildlife management costs for the Spada Lake Tract; in 1987 dollars.

Period	Habitat Enhancement Costs
1986-1990	15,336
1991-1995	18,840
1996-2000	16,274
2001-2005	8,554
2006-2010	17,858
2011-2015	8,554
2016-2020	11,357
2021-2025	8,554
2026-2030	11,356
2031-2035	8,554
2036-2040	11,357
2041-2045	8,554
2046-2050	11,356
2051-2055	8,554
2056-2060	11,357
TOTAL	$176,415

Table 7.15 Summary of wildlife management costs for the Williamson Creek Tract; in 1987 dollars.

	Costs		
Period	Acquisition	Enhancement	Total
1986-1990	1,056,748	12,317	1,069,065
1991-1995	0	6,110	6,110
1996-2000	0	8,129	8,129
2001-2005	0	5,774	5,774
2006-2010	0	8,129	8,129
2011-2015	0	5,774	5,774
2016-2020	0	8,129	8,129
2021-2025	0	5,774	5,774
2026-2030	0	8,129	8,129
2031-2035	0	5,774	5,774
2036-2040	0	8,129	8,129
2041-2045	0	5,774	5,774
2046-2050	0	8,129	8,129
2051-2055	0	5,774	5,774
2056-2060	0	8,129	8,129
TOTAL	$1,056,748	$109,974	$1,166,722

Table 7.16 Summary of costs for the Jackson Project wildlife habitat management plan; in 1987 dollars.

	Costs			
Tract	Land Acquisition	Habitat Enhancement	Forest Management	Total
Lake Chaplain	0	$2,298,921	$2,311,033	$4,609,954
Lost Lake	$424,476	$730,755	(459,552)	$695,679
Project Facility Lands	0	$112,642	0	$112,642
Spada Lake	0	$176,415	0	$176,415
Williamson Creek	$1,056,748	$109,974	0	$1,166,722
TOTAL	$1,481,224	$3,428,707	$1,851,481	$6,761,412

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9.0 GLOSSARY

Average Annual Habitat Units (AAHU) - the total number of habitat units lost or gained as a result of a project or proposed action, divided by the life of the project or action.

Age Class - an aggregation of trees with a range in age between the oldest and the youngest of no more than 20 years.

Blowdown - live trees that fall to the ground due to wind.

Broadcast Burn - intentional burning of logging slash that is distributed randomly over a logging unit and not piled or confined to a limited area.

Browse - shrubs used as a food source by wildlife, particularly black-tailed deer.

Canopy - the continuous cover of branches and foliage formed by the crowns of adjacent trees and other woody growth.

Canopy Closure - a measure of the percent of potential open space occupied by the collective tree crowns in a stand.

Cavity Dependent Species - wildlife species that depend upon tree cavities for one or more essential life requirements, typically cover or breeding.

Commercial Thin - the removal of a portion of the merchantable timber from a forest stand.

Cover - vegetation and/or physiographic features used by wildlife for protection from predators or to lessen the effects of weather.

Cover Type - a classification of environmental conditions based upon plant associations or physiography.

Cutting Unit - a unit designated for tree harvest and subsequent re-planting.

Diameter at Breast Height (DBH) - a measurement taken of tree diameter at the breast height of a person standing next to the tree (usually considered 42 inches).

Dominant Trees - trees in the forest stand whose crowns rise above the general canopy level and receive sunlight from the top and sides.

Drumming Stage - usually a log or stump used by a ruffed grouse for drumming courtship display.

Early-Successional Species - wildlife species that find optimal habitat in early-successional stand condition forests.

Edge - the unique set of habitat conditions formed at the boundary between two or more plant communities of differing structure, such as forest and meadow.

Emergent Vegetation - aquatic plants that are rooted below water but not wholly submerged.

Emergent Wetland - wetland area dominated by perennial plants like herbaceous hydrophytes, excluding mosses and lichens; vegetation is present for most of the growing season in most years.

Escape Cover - cover that provides an animal security from predators or a pathway to security.

Evaluation Species - wildlife species that are used to evaluate or analyze habitat conditions and changes in habitat through the use of HEP.

Forage - vegetation used for food by wildlife.

Forb - a non-woody, broadleaf plant.

Forested Wetland - wetland area characterized by woody vegetation at least 20 feet tall.

Green Tree Clumps - a group of live trees left during timber harvest to provide snags to succeeding stands.

Habitat Evaluation Procedures (HEP) - a method devised by the U.S. Fish and Wildlife Service to quantify and assess impacts and relative values of wildlife habitat changes.

Habitat Suitability Indices - a unitless number between 0.0 and 1.0 where, 0.0 represents unsuitable habitat and 1.0 represents optimal habitat for a given species of wildlife.

Habitat Type - a classification of environmental settings characterized by the dominant vegetation present.

Habitat Unit (HU) - a value obtained by multiplying an evaluation species' Habitat Suitability Index (HSI) by the size of the area for which the HSI was calculated.

Hardwoods - trees distinguished by the presence of vessels in wood; usually broad-leaved trees such as alder, maple, cottonwood and madrone.

Hard Snag - a snag composed of sound wood, often merchantable.

Harvest - total overstory removal of all or part of a forested stand.

Heart Rot - fungal rot confined to the heartwood of a tree and typically leading to the death of the tree.

Hedging - cropping of shrubs and other plants by feeding animals, usually deer or elk.

HEP - see Habitat Evaluation Procedures.

Herbaceous Vegetation - vegetation growing close to the ground that does not develop persistent woody tissue, usually lasting for a single growing season.

Hiding Cover - any vegetation capable of hiding 90 percent of standing adult deer from the view of a human at a distance of 200 feet or more.

Home Range - the area which an animal traverses and utilizes in normal activities.

Indicator Species - wildlife species whose life requirements are used in wildlife management to indicate the well-being of a group of species.

Landing - a cleared area within or adjacent to timber harvest activity where logs are piled and stacked before loading.

Late-successional Species - wildlife species that find optimal habitat in late-successional stand condition forests.

Litterfall - small material such as leaves, cones, needles and twigs that fall to the forest floor.

Loafing Structures - logs, stumps or other material in an aquatic environment used by waterfowl for resting.

Management Unit - a subdivision of a management tract based on topography, management constraints or some other concern; made up of a number of stands.

Multi-layered Canopy - forest stand condition with two or more distinct tree layers in the canopy.

Non-Persistent Emergent Wetland - emergent wetland subclass that is dominated by plants that fall to the surface of the substrate or below the water surface at the end of the growing season so that, at certain times of the year, there is no obvious sign of emergent vegetation.

Old-growth Forest - coniferous forest that is at least 200 years old and has minimal history of human disturbance.

Overstory - a collective term for the trees in a forest stand that are greater than 20 feet tall.

Palustrine - collective term used to describe vegetated wetlands such as pond, bog, fen, marsh, swamp and prairie; includes vegetated wetland surrounding rivers, lakes and reservoirs.

Passerine Birds - song birds (family Passeriformes).

Persistent Emergent Wetland - wetland dominated by emergent plants that remain standing year-round.

Pre-commercial Thin - the practice of removing some trees of less than merchantable size from a stand to alter tree growth and form and/or alter habitat.

Primary Cavity Nester (Excavator) - wildlife species that excavate cavities in snags.

Primary Roads - usually paved roads that are used for daily traffic by all types of vehicles (i.e., Chaplain Creek Road).

Raptors - general term grouping predatory birds such as eagles, falcons, hawks and owls.

Riparian - transitional area between true wetlands and upland terrestrial areas where the vegetation and microclimate are influenced by perennial or seasonal water; may extend inland for considerable distances.

Rotation - schedule of cutting timbered areas, measured in number of years between harvests.

Sapling - a young deciduous or coniferous tree with a DBH between 1 and 4 inches.

Scrub-Shrub Wetland - wetland area dominated by woody vegetation less than 20 feet tall; includes trees or shrubs that are small or stunted because of environmental conditions.

Secondary Cavity Nester - wildlife species that nest in cavities created by cavity excavating species.

Secondary Roads - temporarily or seasonally used gravel roads that may be unfit for passenger cars.

Second Growth Forest - term commonly used to refer to a forest that is in the process of regrowth after timber harvest of old-growth.

Seep - the emergence of ground water causing saturated soils.

Silviculture - the theory and practice of controlling forest establishment, composition, structure and growth.

Site Index - a measurement of forest site productivity based upon the average height of the dominant trees at a specified age, typically 50 years.

Skyline Yarding - a cable yarding system providing a tower or spar to lift at least one end of a log off the ground when dragging logs to a landing.

Slash - the residue, usually branches, logs and small trees left on the ground following timber harvest.

Snag - a standing dead tree.

Soft Snag - a snag composed of wood primarily in advanced stages of decay.

Stand - a forest or other community sufficiently uniform in species composition, age or arrangement to be distinguished from other communities.

Stand Condition - a description of the vegetative structure and species composition of a forest stand relative to the successional process.

Stand Diversity - a relative measure of the structural complexity of a forest community; increases with horizontal layering and patchiness of the overstory.

Succession - the predictable process of change in species composition and structure of a forest community as it develops after fire or logging.

Talus - the accumulation of broken rock and boulders found in steep sloped areas or at the base of cliffs.

Thermal Cover - vegetative cover used by animals to modify the adverse effects of weather; a forest stand that is at least 40 feet in height with tree canopy closure of at least 70 percent.

Tract - one of the five major parcels of the management lands.

Tractor Yarding - a method for bringing logs to a landing area utilizing a tractor or skidder; usually used in gentle-sloped areas.

Understory - vegetation growing beneath a forest canopy up to a height of approximately 20 feet.

Upland - term used to distinguish terrestrial habitat from aquatic, wetland, or low-lying habitat.

Watershed - the geographic area that contributes surface water to a single river, lake or reservoir.

Wetland - lands that are covered by shallow water or are seasonally or permanently saturated with water at, near or above the soil surface; usually supporting the growth of hydrophytes.

Windfirm - the term used to describe a tree or trees that can withstand normal high winds while standing alone or in small clumps.