

**FISH AND WILDLIFE HABITAT
IN MANAGED FORESTS
RESEARCH PROGRAM**

PROGRESS REPORTS

FY 2003
(July 1, 2002 - June 30, 2003)

**FOREST RESEARCH LABORATORY
OREGON STATE UNIVERSITY**

February 21, 2003

Foreword

The 1993 Oregon Legislature added \$0.10 per thousand board feet to the Oregon Forest Products Harvest Tax rate for research through the Forest Research Laboratory (FRL) to provide new information about meeting the needs of fish and wildlife in managed forests of Oregon. The program of research was initiated on November 1, 1994, with advice from a Technical Advisory Committee comprised of fish and wildlife specialists and forest managers from government, industry and non-industrial land owners that provided recommendations to the FRL Director. The program is conducted within the Forest Science, Forest Resources, and the Forest Engineering Departments.

In 1994, the FRL program included significant research on fish and wildlife in managed forests. These efforts were funded with revenues from the State and grants obtained from various sources. Normally an increase in the Harvest Tax rate would result in a significant expansion and acceleration of research. Unfortunately, the increased Harvest Tax revenue that year was offset by the effects of Measure 5 and decreased timber harvest on federal lands. This put many programs that would enhance our knowledge about fish and wildlife values in managed forests in jeopardy. As a consequence, the FRL had limited ability to initiate a large number of totally new studies in this area. However, the revenues from the increased Harvest Tax rate ensured timely completion of several studies on going in 1994, and initiation of new work in a few key areas.

Based on the harvest level at the time, the FRL program was initially funded by \$457,485 in revenues annually from the increase in the Harvest Tax rate. Activities were selected by College program leaders based on advice received from the Technical Advisory Committee and in consultation with key faculty. The FY2003 program reflects several changes from FY2002. Four research projects were completed. The budget for FY2003 is \$345,000, a result of the projected harvest of 3.45 billion board feet. Based on the advice of the program's advisory committee, these resources are sufficient to initiate one new project and continue six research projects.

Many of these activities have been conducted with funds from several sources, making their "value" far greater than the funds from the Harvest Tax. This is not duplication of funding, but shows how Harvest Tax funds are leveraging other resources, making "the dollars go farther." Without the FRL funds AND the other funds, most of these projects would not be possible.

Other FRL programs also contribute to or complement the goals of this research program. Depending on when these efforts were initiated, they were initially financed with lottery funds, the General Fund, or grant funds. These activities were not included in program documents (either initially or in FY2003) because they are not explicitly part of the effort funded by the increase in Harvest Tax rate.

I am confident this program will help with both policy and management - to the benefit of the people of Oregon.

Hal Salwasser, Dean
Forest Research Laboratory
July 1, 2002

**FISH AND WILDLIFE HABITAT IN MANAGED FORESTS
RESEARCH PROGRAM**

PROGRESS REPORTS
February 21, 2003

This is a compilation of the progress reports from the projects and activities that are part of the FRL research program on fish and wildlife habitat in managed forests funded by the 1993 legislative increase in the Oregon Forest Products Harvest Tax rate. The program is described in detail in the November 1, 1994 document "MEETING FISH AND WILDLIFE NEEDS IN MANAGED FOREST, A PROGRAM OF RESEARCH of the FOREST RESEARCH LABORATORY."

This is the eighth full progress report for this Program.

This document highlights the following:

- a. Seven research projects were active in FY 2003, including six continuing from the previous year and one new one. Of these, two are completed or not scheduled for further funding in FY2004. Two projects that were scheduled to end in FY2003 have requested extensions into FY2004.
- b. For projects or functions that are ending, progress is reported as a termination report and provides a final overview of the accomplishments and implications of the efforts to date.

Steven D. Tesch
Program Manager

Table of Contents

Page

New Projects

Research

- Study 1: Forest Management Strategies in Hinkle Creek Watersheds: Evaluation.....1
of Baseline Seasonal Stream Water Nutrient Concentrations and
Soil Resources (2002 – 2006)

Continuing Projects and Activities

Research Projects

- Study 1: Snags and Reserved Green Trees: Mortality Rates and Primary Cavity6
Nester Use (2000 – 2003)
- Study 2: Influence of Silvicultural Treatments and Manipulation of Downed Wood on.....8
Abundance and Demographics of Small Mammals (1999 – 12/2002)
(Extension requested to 12/2003)
- Study 3: The Role of Perennial, Non-Fish-Bearing Streams in the Temperature13
and Flow Regimes of Small, Fish-Bearing Headwater Streams During
Summer in Western Oregon (2001 – 2004)
- Study 4: Examining Linkages Between Multi-Scaled Riparian Data, Fish Habitat.....18
Characteristics and Coastal Cutthroat Trout (*Onchorhynchus clarki clarki*)
Populations (2001 – 2003) (Extension requested to 9/2003)
- Study 5: Influence of Alternative Silvicultural Practices on Songbirds (2001 – 2005).....20
- Study 6: The Magnitude and Timing of Surface Runoff from Forest Roads Relative..... 23
to Stream Flow in Live Stream-crossing Culverts in the Oak Creek Watershed
(2001 – 2003)

NEW PROJECTS

Following guidance by the Technical Advisory Committee and final approval by the FRL Director, one new activity was initiated in FY 2003. New projects are intended to meet high priority needs identified during the annual advisory committee meeting.

Research Projects

Title: Forest Management Strategies in Hinkle Creek Watersheds: Evaluation of Baseline Seasonal Stream Water Nutrient Concentrations and Soil Resources

Principal Investigator: Kermit Cromack, Jr., Forest Science Department, OSU

Co-Principal Investigators: Dave Hibbs, Forest Science Department, OSU; Arne Skaugset and Stephen Schoenholtz, Forest Engineering Department, OSU

Relevance to program mission: This research addresses the need to obtain baseline data for both stream chemistry and soil resources for two forest watersheds, the North and South Forks of Hinkle Creek Research and Demonstration Area Project. Current forest management practices are designed to promote sustainable silvicultural systems on these two paired watersheds, which are productive for timber, water, fish, and wildlife resources. A solid representative database for both stream and soil nutrients in these watersheds would provide a model upon which to help gauge the effects of current and expected intensive forest management practices on industrial forest land. It would be particularly worthwhile to obtain such data from the Hinkle Creek watersheds prior to initiation of an anticipated 10-year study of intensive forest management.

Objectives: There are two main objectives: 1) to obtain seasonal water nutrient concentration data for two consecutive years in six headwater streams, and in the North and South forks of Hinkle Creek. Stream nutrients to be measured include: total N, P, and base cations (Ca, K, Mg, Na), inorganic carbon (DIC), dissolved organic N (DON), and inorganic N (DIN), plus stream pH, collected seasonally; 2) to obtain data for soil resources on these watersheds (with emphasis on those for riparian zones), including soil physical properties (porosity and bulk density), pH, soil texture, and soil C, N, P, S, base cations (Ca, Mg, K, Na), cation exchange capacity, and availability of soil N and P. This research is designed to integrate with the proposed Hinkle Creek Research and Demonstration Area Project on Hydrology and Water Quality being led by Arne Skaugset, Forest Engineering Department at OSU.

Overview: Oregon has highly productive forests growing on soils that can be effectively managed for timber resources while maintaining stream water quality suitable for fish and wildlife resources. In addition to maintaining productive forests, one goal of current forest management is to maintain stream water of high quality for fish and wildlife. The same nutrients which are essential in adequate quantities for tree growth (N, P, and base cations, plus micronutrients) also are required by both fish and wildlife species. This project would provide a valuable initial database of stream nutrient concentrations and soil resources for the proposed new Hinkle Creek Research and Demonstration Area Project.

Approach: To accomplish the first objective for obtaining seasonal nutrient concentration data, we will collect samples directly from streams seasonally, while minimizing disturbance to stream sediment. Samples will be transported in coolers on ice and taken within 24 hrs. to the Co-operative Chemical Analytical Laboratory at OSU for water analysis. The second objective, to collect soil samples in riparian zones and upslope forest areas, will be accomplished using soil coring at sites selected by stratified random sampling within each paired watershed area. In addition,

representative soil pits will be dug to obtain soil descriptions and soil parent materials.

Project Results to Date: In September, 2002, we selected two control and four treatment watersheds for stream sampling, in addition to stream sample sites just above the confluence of the North and South Forks of Hinkle Creek, for collection of stream samples for chemical analyses. We also recruited Lance George as an M.S. graduate student working jointly in Forest Science and Forest Engineering for our Hinkle Creek Study.

Our first stream samples were collected on October 24, 2002, with additional samples collected each month during November and December, 2002, and January, 2003. Complete stream chemistry results are available for October, 2002, and are presented in Table 1. Results are given for the following analyses: unfiltered total N, dissolved total N, unfiltered total P, dissolved total P, dissolved PO₄-P, alkaline HCO₃-C, conductance, NO₃-N + NO₂-N, NH₄-N, dissolved Si, dissolved NA, dissolved K, dissolved Ca, dissolved Mg, dissolved SO₄-S, dissolved Cl, suspended sediment, and pH. All water N concentrations are low, except for one higher NO₃-N value for treatment watershed T-14. This small watershed was partially cut over about 20% of its area prior to initiation of the integrated Hinkle Creek Project in 2002. Results for NH₄-N show that this inorganic form of N is present in low concentrations in all of these watersheds. Organic N, as both particulate, unfiltered total N and as dissolved total N, is also present in low concentrations. Phosphorus and SO₄-S concentrations are also low. Among base cations, Ca is present in higher concentrations than K or Mg. Suspended sediment was low during October at a time of low stream flow following a dry summer season.

Results for N and P are given in Table 2 for November, 2002. All other chemical analyses are in progress for November, December and January. Nitrogen concentrations for NO₃-N in November for the South Fork of Hinkle Creek and for the treatment watershed T-14, show higher concentrations than for the other collection sites. Stream P concentrations are similar for both October and November.

When comparing stream chemistry data between Hinkle Creek and the H. J. Andrews LTER small watersheds, (Tables 3 and 4), we found that results for many of the analyses are broadly similar, especially for N and P. Cation concentrations were higher for Ca and Mg in the Hinkle Creek watersheds than for the H. J. Andrews watershed #10 (Sollins et al., 1980). More recent H. J. Andrews LTER stream chemistry data from Vanderbilt et al. (2002) show that both inorganic N and organic N concentrations are low (Table 4) and are comparable to the Hinkle Creek watersheds. Work done in the Alsea River basin watersheds (Brown et al., 1973) show generally higher concentrations for NO₃-N (Table 5) than for Hinkle Creek, except for the T-14 watershed and the South Fork of Hinkle Creek in November, 2002, which are similar to Alsea Basin NO₃-N concentrations. Forest soils in the Oregon Coast Range generally have higher concentrations of soil N and C (Rothe et al. 2002), and thus may have higher stream NO₃-N concentrations even on undisturbed control sites (Brown et al. 1973).

Timeline: Winter /Spring/Summer/Fall 2003 - continue collection of stream and soil samples; Winter/Spring/Summer/Fall 2004 - continue stream nutrient sample collection and soil sample collection and analysis; Winter/Spring/Summer 2005 - finish stream and soil collections and data analysis; Fall/Winter/Spring 2005/2006 - finish theses/dissertation, submit final report and write manuscripts based upon these results.

Tables

Table 1. October, 2002 Hinkle Creek Watershed Data.

October 2002	Control CO2	Control CO9	Hinkle Creek North Fork Confl.	Hinkle Creek South Fork Confl.	Treat. TO3	Treat. T10	Treat. T12	Treat. T14
Unfiltered Total - N mg/L	0.05	0.03	0.05	0.04	0.04	0.08	0.11	0.04
Dissolved Total- N mg/L	0.01*	0.01*	0.03	0.02	0.02	0.00*	0.03	0.01*
Unfiltered Total - P mg/L	0.031	0.015	0.013	0.013	0.051	0.033	0.046	0.019
Dissolved Total - P mg/L	0.022	0.013	0.013	0.010	0.050	0.019	0.025	0.018
Dissolved PO ₄ -P mg/L	0.018	0.009	0.006	0.005	0.045	0.015	0.018	0.013
Alkaline HCO ₃ - C mg/L	7.19	12.64	8.90	7.31	7.75	7.97	7.29	8.78
Conductance µs/cm	59.9	102.3	75.5	61.8	66.6	66.7	61.7	77.1
NO ₃ -N + NO ₂ - N mg/L	0.022	0.014	0.000*	0.000*	0.027	0.010	0.014	0.394
NH ₄ - N mg/L	0.004	0.003	0.004	0.006	0.004	0.002*	0.004	0.004
Dissolved Si mg/L	9.73	9.10	8.34	9.30	11.68	9.31	8.52	8.67
Dissolved Na mg/L	4.86	5.43	5.40	4.21	6.47	3.90	4.22	4.27
Dissolved K mg/L	0.61	0.36	0.66	0.49	0.65	0.30	0.46	0.29
Dissolved Ca mg/L	5.14	10.59	7.10	6.14	5.14	7.36	6.26	8.31
Dissolved Mg mg/L	1.1461	3.121	2.022	1.611	1.398	1.648	1.414	2.086
Dissolved SO ₄ - S mg/L	0.20	0.12	0.12	0.12	0.28	0.14	0.14	0.15
Dissolved Cl mg/L	1.40	1.59	2.04	1.38	1.56	1.34	1.36	1.56
Suspended sediment mg/L	10.08	0.69	0.80	0.48	12.14	2.21	21.07	0.19
pH	7.5	7.7	7.6	7.5	7.6	7.4	7.6	7.7

*Denotes below level of detection for a given analysis.

Table 2. November, 2002 Hinkle Creek Watershed Data.

November 2002	Control CO2	Control CO9	Hinkle Creek North Fork Confl.	Hinkle Creek South Fork Confl.	Treat. TO3	Treat. T10	Treat. T12	Treat. T14
Unfiltered Total - N mg/L	0.06	N/A	0.06	0.07	0.05	0.05	0.05	0.08
Dissolved Total- N mg/L	0.04	N/A	0.05	0.07	0.05	0.02	0.05	0.05
Unfiltered Total - P mg/L	0.027	N/A	0.017	0.011	0.050	0.023	0.024	0.016
Dissolved Total - P mg/L	0.023	N/A	0.013	0.009	0.047	0.017	0.020	0.012
Dissolved PO ₄ -P mg/L	0.018	N/A	0.008	0.005	0.040	0.013	0.015	0.009
NO ₃ - N + NO ₂ - N mg/L	0.001	N/A	0.002	0.148	0.010	0.001	0.004	1.114
NH ₄ - N mg/L	0.008	N/A	0.001*	0.001*	0.003	0.000*	0.016	0.008
Temp. °C	9.0	N/A	9.0	9.0	9.0	9.0	9.5	9.0

*Denotes below level of detection for a given analysis.

N/A denotes not analyzed.

Table 3. Stream chemistry data from HJ Andrews WS#10 weir from 1973-75 (Sollins et al.1980).

NO ₃ -N + NO ₂ -N mg/L	0.19
Kjeldahl N mg/L	0.035
Na mg/L	1.96
K mg/L	0.339
Ca mg/L	3.20
Alkalinity HCO ₃ -C mg/L	4.17
Total P mg/L	0.054
SO ₄ -S mg/L	N/A
Cl mg/L	N/A
Mg mg/L	0.834

N/A denotes not analyzed.

Table 4. Average inorganic and organic N concentrations for three old-growth-dominated streams at HJ Andrews (Vanderbilt et al., 2002).

Concentration	WS #2 (1982-2001)	WS #9 (1969-2001)	WS #8 (1972-2001)
NO ₃ -N mg/L	0.001	0.003	0.004
NH ₄ -N mg/L	0.007	0.008	0.009
DON mg/L	0.02	0.04	0.02
PON mg/L	0.02	0.02	0.01

DON denotes dissolved organic N.

PON denotes particulate organic N.

Table 5. Annual mean NO₃-N (mg/L) concentrations for three streams in the Alsea River basin both before (1965-1966) and after (1967-1968) treatments (Brown et al., 1973).

Year	Flynn Creek (uncut control)	Needle Branch (clear-cut)	Deer Creek (patch-cut)
1965	1.21	0.12	1.12
1966	1.16	0.19	0.98
1967	1.18	0.44	1.21
1968	1.18	0.43	1.12

References

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- Vanderbilt, K. L., K. Lajtha, and F. J. Swanson. 2002. Biogeochemistry of unpolluted forested watersheds in the Oregon Cascades: temporal patterns of precipitation and stream nitrogen fluxes. *Biogeochemistry* 58: 1-31.

CONTINUING RESEARCH PROJECTS

Study 1: Snags and Reserved Green Trees: Mortality Rates and Primary Cavity Nester Use

Principal Investigator: Chris C. Maguire and Scott Walter, Forest Science Department, OSU

Objectives: In managed forests, considerable emphasis is placed on retaining and creating snags for cavity-nester use and in placing green trees in reserve for future snag replacement. We currently have a poor understanding of snag longevity and the permanence of reserved green trees in westside forests subject to different silvicultural practices. Quantification of the fall rates of snags and green trees, and of the temporal use of decaying snags by avian species, will provide data to effectively manage snags as wildlife habitat.

This study was designed to:

- (1) quantify the 10-year fall rates of isolated and clustered snags in clearcut, two-story, and group selection stands;
- (2) quantify the 10-year mortality rates of green trees under the same silvicultural treatments;
- (3) compare avian cavity-nester use of snags after 10-years with results from the first 5-years.

Progress and Accomplishments: Between 1989 and 1991, 30 stands in McDonald-Dunn Forest under the College of Forestry Integrated Research Program (CFIRP) were subjected to three harvest treatments: clearcut, two-story, and group selection. In addition, green trees were topped (in excess of 1,000 trees) at a mean height of 17 m (1.5/ac) to create snags (3.8/ha; 1.5/ac) in either isolated or clumped distributions. Avian use of snags was assessed in 1995 providing information on use during the first 5-years following snag creation. One objective of the current study is to follow-up the 5-year study with a re-assessment of avian snag use 10-years following snag creation. The long-term intent of the project is to build a temporal database focused on avian snag use and snag longevity at 5-year intervals.

During the spring breeding and rearing season, birds make frequent trips between the cavity and the environment for the purpose of feeding young. During spring 2000, each snag was observed three times to assess current and past nesting and feeding use. All species of birds using snags were recorded along with cavity location information. These data are being used to quantify the temporal pattern of snag use and to determine whether clumped snags are utilized more often than scattered snags.

In conjunction with cavity nester and snag use surveys, snag longevity was assessed. Because snags that have fallen in the decade since their creation have not been salvaged, snag mortality was accurately quantified from a total count. These data are being used to evaluate differences in fall rates between silvicultural treatments and snag spatial arrangements.

It is not uncommon under current forest management practices to leave green trees in harvest units to provide a temporal source of snags. The proximity of leave green trees to other trees is likely to have a significant influence on their standing duration. Thus fall rates of green trees in all three silvicultural treatments were quantified in summer/fall 2001 using a complete count. These data will provide for comparison of the survival potential of green trees under silvicultural regimes reflecting different densities and retention patterns of trees.

Scott Walter, a masters candidate from the Department of Forest Science, is undertaking this project in partial fulfillment of his degree requirements. All fieldwork was completed between April 2000 and February 2002. Analysis of cavity-nesting bird and snag data is complete; analysis of green tree

retention is still in progress. Scott's thesis should be available in summer 2003. The thesis is being written as separate manuscripts for each chapter, so we anticipate sending manuscripts out for publication review during the second half of 2003. No new funding is required for FY2003-2004.

Preliminary results of the study include the following. Less than one percent of the created snags (N = 8) have broken or fallen during the 10 years since their creation. Naturally created snags during the last decade have exceeded fall rates resulting in a net increase in snags. Snag cavities have more than doubled in the last five years. Use by birds does not differ between scattered and clumped snags. Cavity-nesting bird richness is greatest in clearcuts (N = 8 species) followed by two-story (N = 7) and group selection (N = 5) stands. Created "snags" with live branches contain fewer cavities than totally dead snags. Analyses involving green tree retention are still in progress.

This is a progress report.

Study 2: Influence of Silvicultural Treatments and Manipulation of Downed Wood on Abundance and Demographics of Small Mammals (1999-2002)

Principal Investigator: John P. Hayes, Department of Forest Science

Relevance of topic to program mission: Understanding the influences of a diversity of silvicultural approaches on wildlife and use of habitat components by wildlife in forests is central to the program's mission. This research will fill some of the gaps in our understanding of the influences of alternative silvicultural practices, green tree retention, and addition of dead wood to forest stands on wildlife.

Background: Interactions between components of stand structure and the abundance, survival, and reproductive success of wildlife can be complex. Although we have developed a more clear understanding of relationships between some aspects of stand structure and abundance of some species of wildlife, our understanding of the relationships between many structural elements and wildlife abundance is poorly developed, and information concerning the influence of stand structure on survival and reproductive success is almost totally lacking for most species of wildlife. Ecological theory regarding demographic responses of wildlife to silvicultural manipulations suggests a paradox: population abundance is not always an adequate index to habitat quality. Areas may function as "population sinks" or "ecological traps" that provide adequate habitat to attract animals to colonize a site, but do not provide adequate resources to promote self-sustaining populations. Understanding the influences of silvicultural activities on demographic parameters such as survival and reproduction is critical to fully understanding the ramifications of various management strategies on wildlife.

Wildlife ecologists generally agree that fallen dead wood is a key habitat component for many species of wildlife. However, our understanding of the quantitative relationships between fallen dead wood and wildlife is extremely poor. Moreover, most of the existing information is based on observational, correlative studies that lack predictive power. As a result, it is not possible to fully evaluate the ecological costs and benefits of different management strategies.

Objectives: This project has 3 specific objectives: 1) To determine the influence of selected silvicultural activities on the abundance and demographics of small mammals, 2) To determine the response of small mammals to the addition of downed wood in different stand conditions, and 3) To examine the importance of downed wood in path selection by Townsend's chipmunks.

Overview of approach and methods: This study is taking place on the McDonald-Dunn Research Forest in uncut stands and stands harvested between 1989 and 1991. The study is being conducted in three geographic blocks in the Research Forest. In each block, we selected two control stands, two clearcut stands, two patch-cut stands, and two two-story stands for study, for a total of eight stands per block and twenty-four stands in total. Twenty-one of the stands were randomly selected from blocks in the College of Forestry Integrated Research Project (CFIRP) stands, and three additional stands were selected in the nearby area. The three silvicultural treatments were applied to the CFIRP stands between 1989 and 1991. Clearcuts retained 0.5 green trees/acre; patch-cuts removed one-third of the volume in the stand by creating a series of 1/2-acre circular patches; two-story stands uniformly removed three-quarters of the volume throughout the stand; and control stands did not receive any treatment. Prior to treatment, stands were 90 to 130 years old. One stand of each silvicultural treatment within each block was randomly selected to receive additions of downed wood.

We established an 8 x 10 trapping grid (0.63 ha) with 10-m spacing between grid points in each stand. A buffer of at least 35 m (generally >50 m) was maintained between the outer set of traps and the edge of the stand. One large, collapsible Sherman live-trap is placed within 1 m of each grid point; starting April 2000, one tomahawk trap will be placed at every other station (20 tomahawk traps per grid). Small mammal populations will be sampled for 5 nights during the spring (April and May), summer (July and August), and fall (October and November) during the study. During each trap session, traps are baited with peanut butter and a commercial mixture of rolled barley, rolled corn, rolled oats, and cane molasses. Traps are covered with milk containers for insulation and protection from the rain. Traps are checked once a day for 5 days. Each small mammal captured will be identified to species, sex, and reproductive condition, weighed, tagged with a uniquely numbered metal ear tag, and released at the site of capture.

To evaluate the importance of downed wood to path selection by Townsend's chipmunks, we attached spools of lightweight thread to the tails of chipmunks in 6 patch cut stands in summer and fall 2001. Trails were identified and data collected on the use of downed wood every 2 m along the trail.

Progress: This research was initiated in 1999. As of January 2003, we have completed 11 trap sessions (summer and fall 1999, spring, summer, and fall 2000, 2001, 2002). During March and April, 2001, we added a total of 1,474 cf of logs to three clearcuts (11 logs were helicoptered into each stand). A similar volume of wood in the form of whole trees was added to three patch cuts (5 trees were felled in each stand).

During 91,200 trap nights over the entire project, we captured 22 species of small mammals a total of 35,138 times. Deer mice and Townsend's chipmunk were the most abundant species and represented 69.5% and 18.5% of the captures, respectively.

For the silvicultural treatment objective, we completed 5 seasons of trapping (1999 and 2000). In 55,200 trap nights, 6,690 individuals of 18 species of mammals were captured 20,169 times. There are species-specific responses to silviculture treatments with some species being more abundant in control and patch cuts (e.g., northern flying squirrels [Figure 1]) and others generally being more abundant in two-story and clearcut stands (e.g., deer mice [Figure 2]). Townsend's chipmunks had high abundances in clearcut, two-story, and patch cut stands (Figure 3). Patch cut stands offer diverse habitat conditions in a relatively small area and serve as habitat for species that need an overstory canopy and or species that respond to open habitat conditions.

For the downed wood objective, we have completed 11 seasons of trapping (1999, 2000, 2001, and 2002, trapping completed). In 63,600 trap nights, we captured 22 species of small mammals a total of 25,361 times. At this point in the analysis, no differences in the abundance of any small mammals are apparent as a result of the wood treatment (Figures 4 and 5).

We attached spools of thread to 14 Townsend's chipmunks in summer 2001 and 34 chipmunks in fall 2001. Thirty-five thread trails were followed for a combined distance of 5,231.8 m (mean = 116.3 m per chipmunk). On average, 16% of a trail was arboreal (in shrubs and trees) and 54.9% was associated with dead wood. The importance of downed wood to Townsend's chipmunks during path selection awaits further data analysis.

We caution that the summaries presented above are preliminary and that large seasonal and annual cycles in populations of small mammals must be accounted for when interpreting capture data (Figures 1 to 5).

Timeline: Data management and analysis will continue for all 3 objectives. We anticipate completion of a doctoral dissertation on this study by December 2003.

Budget:

FY2004: \$15,000.

This research is partially funded by the Cooperative Forest Ecosystem Research program.

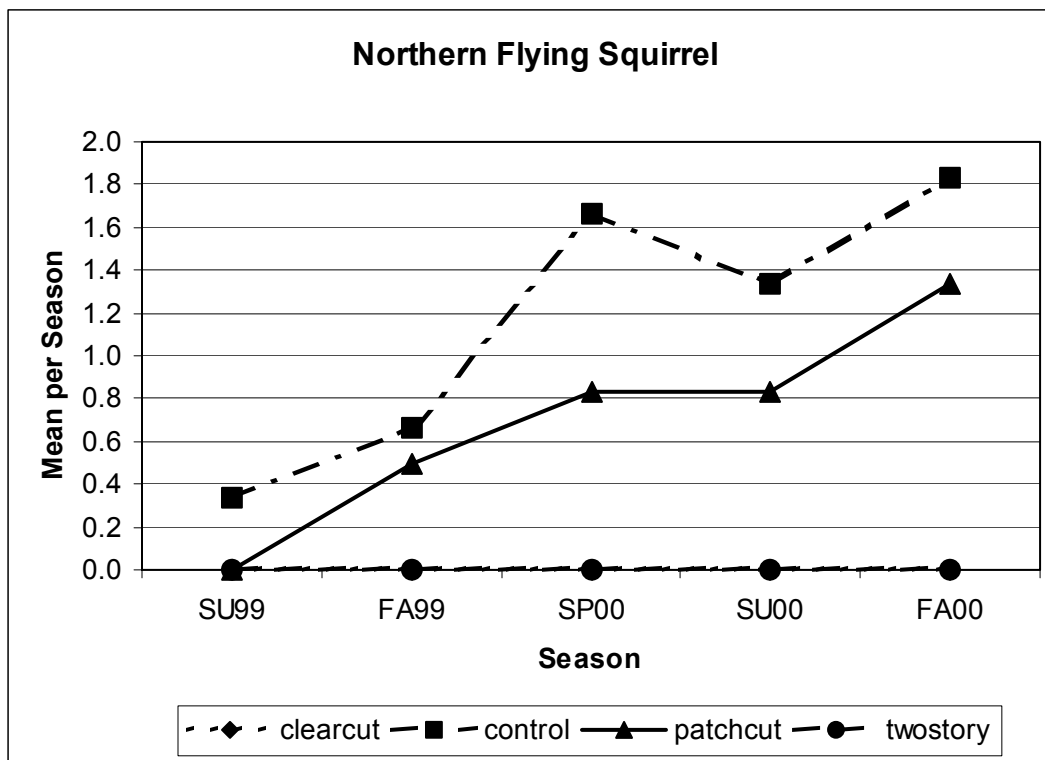


Figure 1. Mean captures of northern flying squirrels by season in stands differing in silvicultural treatments.

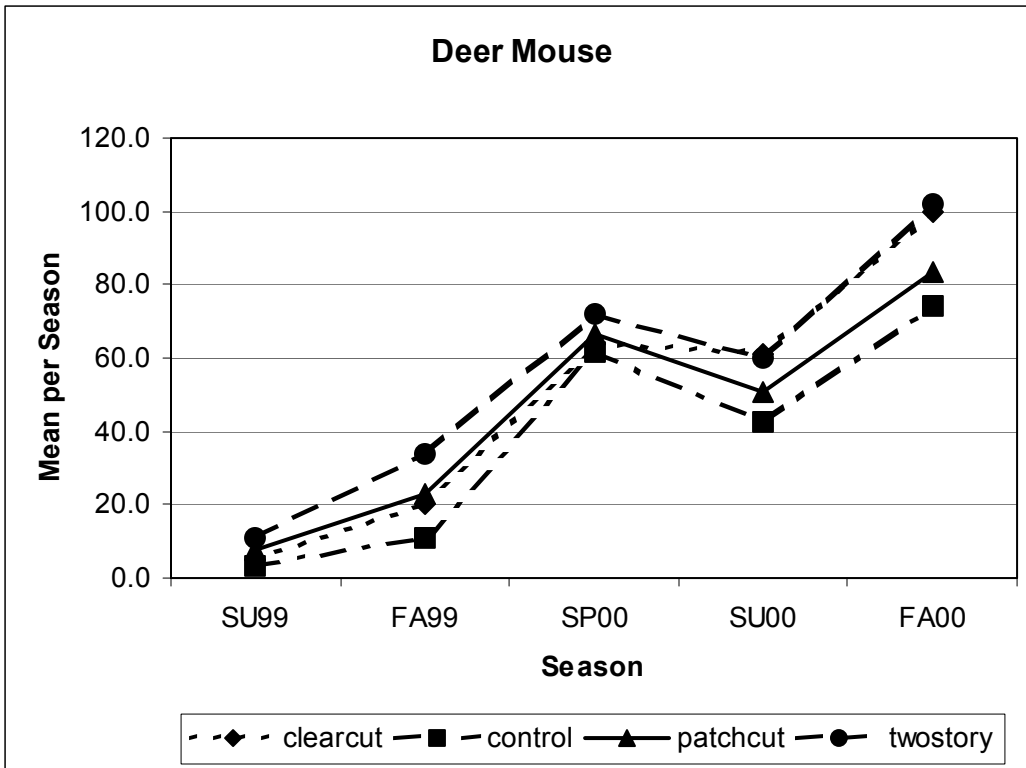


Figure 2. Mean captures of deer mice by season in stands differing in silvicultural treatments.

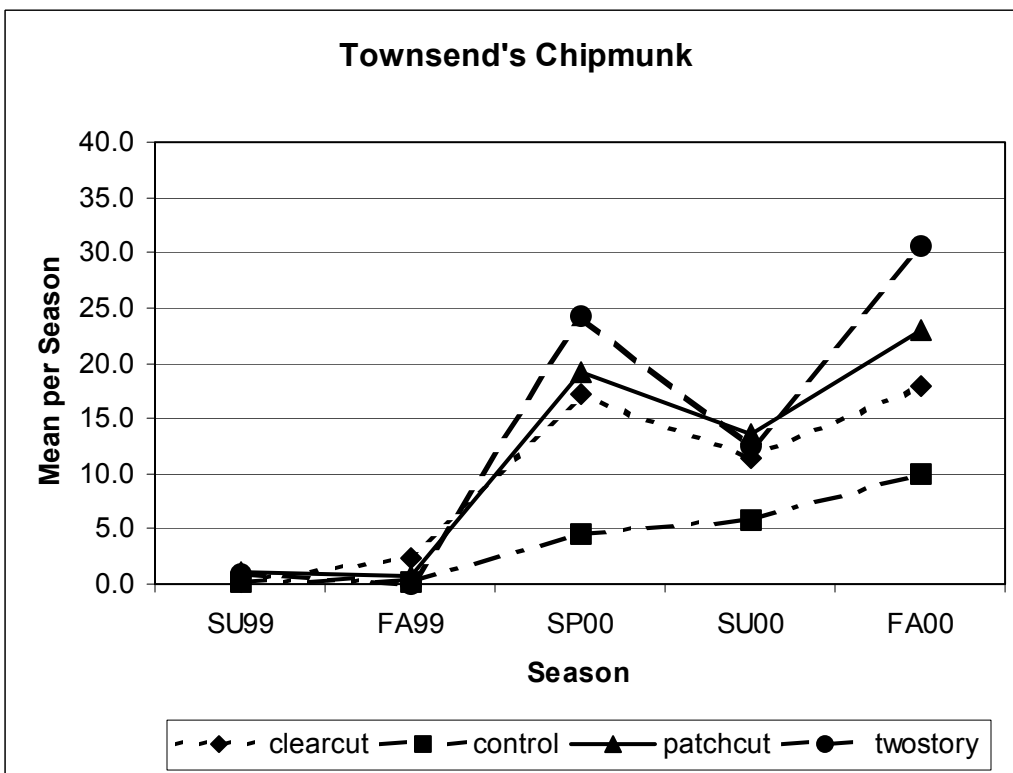


Figure 3. Mean captures of Townsend's chipmunk by in stands differing in silvicultural treatments.

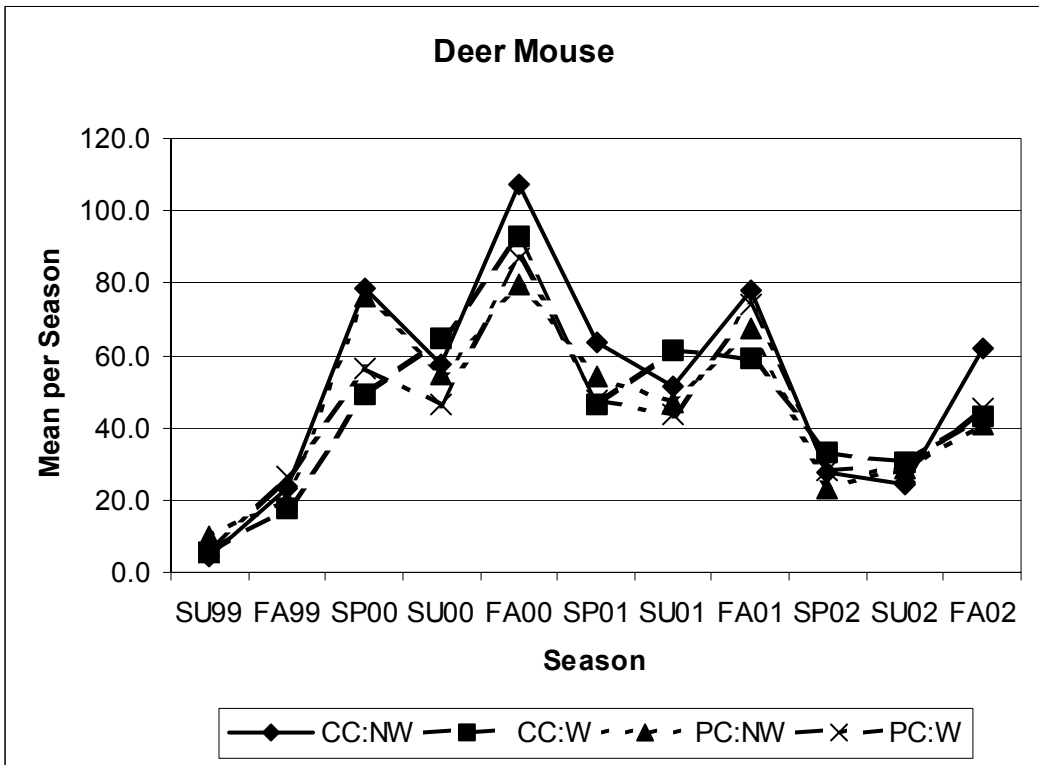


Figure 4. Mean captures of deer mice by season for the wood objective. CC:NW = clearcut with no wood added, CC:W = clearcut with wood added, PC:NW = patch cut with no wood added, PC:W = patch cut with wood added.

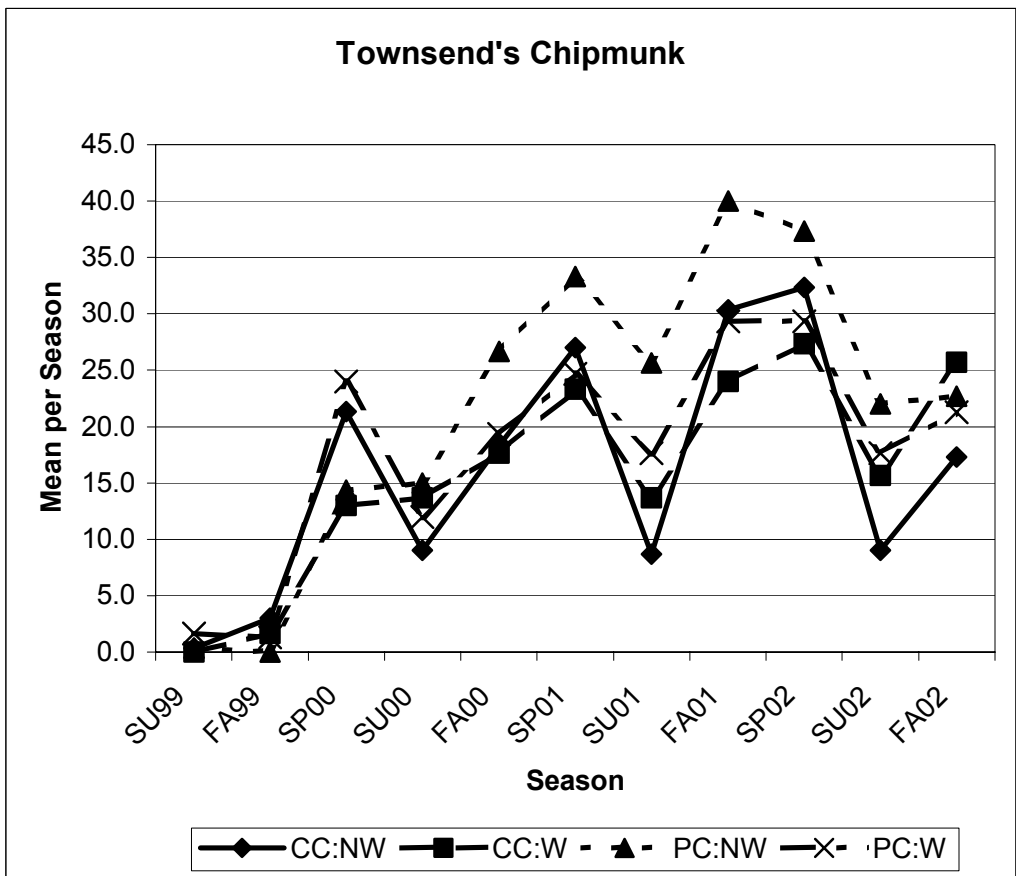


Figure 5. Mean captures of Townsend's chipmunks by season for the wood objective. CC:NW = clearcut with no wood added, CC:W = clearcut with wood added, PC:NW = patch cut with no wood added, PC:W = patch cut with wood added.

Study 3: The Role of Perennial, Non-Fish-Bearing Streams in the Temperature and Flow Regimes of Small, Fish-Bearing Headwater Streams During Summer in Western Oregon (2001-2004)

Principal Investigator: Arne Skaugset, Forest Engineering Department

Problem Statement: Traditional research on timber harvesting and stream temperature has focused on how the removal of stream-adjacent, shade-bearing trees affects the temperature of perennial, fish-bearing streams during summer low flows. Contemporary forest practice rules that prescribe the width and composition of buffer strips adjacent to streams that will, among other objectives, mitigate the effect of the removal of streamside vegetation are a result of this research. In contrast to this traditional research on stream temperature, this project proposes to investigate how timber harvesting on hillslopes adjacent to small, fish-bearing streams, as opposed to within riparian areas, may affect stream temperature. As a part of the Forest Practice Advisory Committee (FPAC) process, a subset of the small, perennial, non-fish-bearing streams (type N streams) have been identified as potentially temperature sensitive. These streams are called type NT streams and they are identified as small, perennial, non-fish-bearing streams whose discharge makes up more than 30 percent of the discharge in the receiving small, fish-bearing stream (small type F).

It is hypothesized that timber harvesting adjacent to unbuffered, type NT streams can result in temperatures that are unacceptable in small, type F streams even though the small, fish bearing stream itself is adequately buffered. In this case, the process governing temperature increases in the buffered small, type F stream is increased temperatures in the unbuffered, type NT streams that, when mixed with water in the small, type F stream, cause stream temperatures that are unacceptable.

The data on this subject in the literature is virtually non-existent. The purpose of this project is two fold. First of all, the temperature regimes of small, type F streams, harvested type NT streams, and fully shaded type N or NT streams will be determined. Secondly, the low flow hydrology of these headwater streams and the shade present for the small, type F streams will be quantified to allow insight into processes.

Objectives:

- 1) To characterize the thermal regimes and low flow hydrology of small, non-fish bearing perennial streams draining both recently harvested and shaded headwater streams.
- 2) To investigate the processes that influence the temperature of small, perennial fish bearing streams during summer low flows, namely the effects of shade and low flow hydrology.

Research Approach: The research approach is to investigate the temperature, streamflow, and shade for 10 small, type F streams throughout western Oregon. Each study stream has a recently harvested type NT stream draining into it and that recently harvested type NT stream is paired with a fully shaded type N stream. Three kinds of data were collected. First of all, thermometers were placed at the mouth of the recently harvested type NT stream, the mouth of the fully shaded type N stream, and the downstream extent of the small, type F stream. These thermometers provided a sample of the thermal regimes of the harvested and unharvested type N streams and the small, type F streams throughout the summer of 2001. Secondly, synoptic studies were undertaken to get high-resolution stream temperature and discharge profiles for each of the small, type F streams during the summer. During these synoptic studies, stream temperature was determined using a handheld thermometer and discharge was determined using a steady state tracer injection method. A tracer was injected at the head of the small, type F stream and the concentration of the tracer in the stream was determined simultaneously with stream temperature. The dilution of the tracer downstream is a

function of increasing discharge. Finally, stream shade and wetted width was determined to account for incoming solar radiation.

Research Accomplishments: During the summer of 2002, eight study sites were sampled. These study sites consisted of six of the study sites from the summer of 2001 sites and two new study sites were added. One of the new study sites is a fully shaded control site for the Hinkle Creek study site and the second new site was in eastern Oregon by Lakeview on the ownership of the Collins Group. Two people were hired to carry out this work. Jeremy Appt, a former Masters student in the Forest Engineering Department, was hired as a Faculty Research Assistant for this project and Hans Gauger was hired as a student worker for the summer. Hans is now a Masters' student with the Forest Engineering Department and has taken on this project as his Master's thesis topic.

In addition to the new study sites, some changes were made in the methods. During the summer of 2001, except for two study sites that were sampled late in the field season, all of the steady state tracer injection tests were one-day tests. The tracer apparatus was set up first thing in the morning and tracer was injected into the stream until the stream reached maximum daily temperature. A problem with this method was that for many streams a steady state condition throughout the experimental reach could not be reached in single day. Thus, for the summer of 2002, we modified the methods to allow multiple day steady state tracer injection tests, to insure that steady state was reached in the study streams. This required different equipment that was heavier and more bulky, thus the more remote study sites from the summer 2001 were not revisited and we used the study sites that could be accessed from a road. Thus only six study sites from 2001 were included in 2002. Running multiple day steady state tracer injection tests instead of single day tests obviously took more time so fewer study sites were visited.

Because multiple day tracer injection tests were run instead of single day tests, running a synoptic of the stream temperature at the heat of the day also became impractical. Instead, the Vemco temperature sensors were placed in the experimental reach of the streams at, nominally, an 8-meter spacing and stream temperature was recorded every five minutes for the duration of the test, which was usually several days. This gave us much greater temporal resolution of stream temperature data during the tracer injection tests.

Finally, two micrometeorological stations were added to the equipment used. At each micrometeorological stations air temperature, solar radiation, relative, humidity, and wind speed were collected also at five-minute intervals. One micrometeorological station was installed in an opening adjacent to the study stream and the other was placed in the study stream at 500 feet during the steady state injector test. Other than these changes in equipment and methods, all methods remained as described in the previous progress report.

Discharge

An increase in discharge was calculated for all of the study streams throughout the study reach. The discharge in the stream at the location of the tracer injection pump ranged from about 0.4 l/sec to 8 l/sec. At six of the study streams the discharge was around 1 l/sec and ranged from 0.4 l/sec to about 1.5 l/sec. At two of the study sites the discharge was markedly greater. For these two streams, the discharges were 3 and 8 l/sec. Both of these study streams were in basalt geology while all the other study sites were in sandstone geology.

The discharge increased throughout the experimental reach of all the streams studied. Every reach would be considered a gaining reach. The greatest percent increases were for those streams with the smallest discharges. For streams with a discharge of 0.5 l/sec the discharge could double or triple but at the end of the study reach the discharge was still not very great. For the streams with the high

discharge, the increase in discharge was about the same absolute order of magnitude, 0.5 to 1.0 l/sec, but the percent increase was much less. Regardless, the increase in discharge did not explain what was going on with the stream temperatures.

Conceptual Model

The data that has been collected to date allows for the development of a conceptual model regarding how we think temperature is propagated downstream. Again, a review of our data and the literature indicate that maximum daily stream temperature and increase, decrease, or stay about the same in any given stream. Here are partial explanations and the development of the conceptual model to help explain these behaviors.

Decrease in Temperature

Streams that are described as cooling or that have a demonstrably lower maximum daily stream temperature 1,000 feet below the harvest unit compared to the temperature at the base of the harvest unit are also associated with very slow longitudinal stream velocities. The very slow longitudinal stream velocities are also associated with landslide-prone terrain and the presence of remnant debris flow deposits. In this case there are two mechanisms that could explain the cooling in these stream reaches. First of all, the velocities are sufficiently slow that the heated water from the clearcut will spend at least one night in a cooling cycle before it makes it to downstream sensors. Thus, all of the energy associated with heating in the harvest unit is lost and on subsequent days that water will not heat up as much because it is in a shaded environment. Thus one reason for cooling is not so much that the water cools down, but rather on subsequent days it doesn't heat up as much.

A second reason may directly have to do with a cooling mechanism. When the stream water goes through a debris flow deposit, it physically cools down. Our data and data from the literature show that stream water at the base of a debris flow deposit is 3 to 5°C cooler than the water flowing into the deposit. This forced hyporheic exchange is a direct cooling mechanism for the stream. Warmer water flows through and around much cooler substrate and heat is shed in that manner. This is an extreme example of hyporheic exchange. For streams where hyporheic exchange is not as forced or extreme but is along the lines of what is more normally expected, a simple exchange of water between the surface water and water in the substrate, this exchange might very well be a direct cooling mechanism. It would just have a smaller effect.

Thus, the conceptual model allows for stream cooling by two mechanisms. One is by hyporheic exchange where there is direct cooling of water by contact with substrate. The second mechanism is by a reduction in heating the stream water in subsequent days because of shade.

Constant Temperature

There are a subset of the streams that stay about constant in daily maximum stream temperature from the top to the bottom of the study stream reach. These streams also have the higher stream velocities. The longitudinal stream velocity is directly proportional to discharge, thus high discharge streams have high velocities and low discharge streams have low velocities. Again two factors are at play here. First of all, the high velocities mean that the water can go from the top to the bottom sensor in a short time, usually in the span of a few hours. The maximum daily temperature at the base of the harvest units usually occurs in mid-afternoon while the maximum temperatures at the downstream end of the reach is in early evening. The water showing up at each sensor has been exposed to virtually the same amount of solar radiation, there is no great differential in the amount of energy received by the water and thus no great differential in heating so they have roughly the same temperature. Also, these streams have the highest discharges and this represents a lot of thermal

inertia. So these are the streams that are going to be hardest to heat up. So they should stay at roughly the same temperature.

Increasing Temperature

The streams that have increasing temperatures have moderate to high velocities and none of them are associated with remnant debris flow deposits. They are also in harvest units and a buffer strip for a small, fish-bearing stream provides the shade. The most logical explanation at this time is that the increase in temperature results from increased heating due to addition solar radiation that reaches the stream from gaps in the buffer strip. With the increased equipment we will have it will be possible to explore this mechanism a little more fully.

Research Plan

- The research plan this summer will be to collect data that will help develop the above conceptual model and also to develop testable hypothesis.
- To the extent feasible and practicable, another five or six study sites will be added to the study.
- While we have one site on the eastside, we will try to get several more if that is possible.
- We will add slug tests to the summer methods as a way to screen those sites that will benefit the most for steady state tests.
- Slug tests will also allow for a greater spatial resolution of data.
- Continue with the use of the micrometeorological data collection.
- Continue with the high spatial and temporal resolution of stream temperature.

Timeline: There is one year left on the project.
Project initiated 2001
Project to be terminated in 2004

Budget: The Oregon Forestry Industries Council (OFIC) remains a partner on this project and has pledged support as needed.

Study 4: Examining Linkages Between Multi-Scaled Riparian Data, Fish Habitat Characteristics and Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*) Populations (2001-2003)

Co-Principal Investigators: Barbara Schrader, Forest Resources Department and Lisa M. Ganio, Forest Science Department

Collaborating Scientist: Robert Gresswell, USGS Forest and Ecosystem Science Center

Background: Riparian vegetation is an important component of stream networks influencing fisheries and wildlife habitat. To analyze the effect of forest management on riparian habitats, researchers and managers need reliable data from the multiple spatial scales of riparian habitat. However, it is difficult to obtain this information because of the complexity of riparian systems.

Riparian vegetation influences fish habitat in a variety of ways - providing shade, litter inputs, increasing stream habitat complexity with inputs of wood, and channel stabilization by streamside roots of trees. It is unclear what level of detail of riparian vegetation is most important in explaining variability of fish habitat and fish abundance. For example, is the composition and variation in vegetation characteristics at the fine scale (fish habitat unit) more important than the vegetation characteristics at a medium (reach, segment) or large (landscape) scale? Does large-scale vegetation data in a Geographic Information System (GIS) layer help explain fish abundance? How well does large-scale vegetation information in GIS layers match the vegetation characteristics on the ground?

In this study we are examining linkages between riparian data from fine, medium and large scales in order to answer questions relating to fish habitat distribution, and eventually contributing to biological questions about population distributions of coastal cutthroat trout (*Oncorhynchus clarki clarki*).

Objectives: Devise a sampling scheme to characterize riparian vegetation to analytically link existing instream fish habitat data to landscape characteristics.

1. Develop a hierarchical analysis examining the relationships between riparian characteristics at small to large scales.
2. Link and aggregate the riparian information developed in this project to the CFER Landscape Study of coastal cutthroat trout distribution and abundance above barriers to fish passage.

Methods: Research is focused in the upper portion of Camp Creek in the Oregon Coast Range. This watershed has been intensively sampled by CFER scientists studying cutthroat trout above barriers to fish passage. Replicate study sites in Camp Creek are being selected in reaches previously sampled for fish presence. Spatially explicit, fine-scale fish habitat data and cutthroat abundance estimates have been collected in this watershed. Riparian vegetation is being sampled at large scale (watershed) and fine-medium scales (habitat unit/reach) using existing GIS vegetation data layers and field sampling techniques. Field sampling will focus on the reach scale, characterizing the width and geomorphic classification of the riparian zone and the vegetation composition and structure adjacent to surveyed streams. A hierarchical modeling approach will be employed as an analysis tool to establish linkages between the data from multiple scales to indices of fish abundance. This study provides a unique opportunity to create a multi-scale riparian data set to link with geo-referenced patterns of known fish habitat and cutthroat trout abundance.

Work completed spring 2001-winter 2003: Data for the Camp Creek Basin has been compiled from multiple sources. This data includes spatial information for multiple GIS layers (sub-basin, stream layer, stream reach and segment layers, vegetation, ownership, elevation, slope, and aspect) as well as fine scale fisheries inventory data (habitat availability and fish abundance by habitat unit, reach

and segment; geomorphic classification and riparian vegetation). Initial analysis has been completed comparing vegetation composition of 30m and 100m buffers around the stream for the length of the stream and by individual reach and segment. Fish occurrence by habitat type, and reach and segment has also been analyzed.

Field sampling to characterize vegetation at the reach level was completed summer 2002. We sampled all accessible reaches and segments. Riparian characteristics sampled included surface height above low flow, vegetation composition, and riparian area width.

We are currently analyzing data to characterize reach-level vegetation patterns relative to fish habitat and abundance using geomorphology characteristics as an integrator between the two. We are comparing three levels of existing vegetation data: dominant cover collected during fish surveys, riparian vegetation collected in the field, and from remotely sensed GIS vegetation layers. We are characterizing reaches by geomorphic classification and assessing variability of riparian vegetation.

Work planned through summer 2003: Completion of M.S. thesis by Mayumi Takahashi. Explore relationships of habitat at various scales using hierarchical analysis techniques. Preparation of manuscript for journal submission.

Request for Additional Funding

Originally we requested funds for 3 years and have received 2 years of funding. We anticipate needing one more quarter of support for the graduate student to prepare the thesis and journal publication.

FY2004 – Summer Term 2003

Grad student support (including computing costs) \$5000

Publication costs \$1800

Total \$6800

Study 5: Influence of Alternative Silvicultural Practices on Songbirds (2001-2005)

Principal Investigator: John P. Hayes, Forest Science Department

Relevance of topic to program mission: Understanding the influences of a diversity of silvicultural approaches on wildlife is central to the program's mission. This research will fill some of the gaps in our understanding of the influences of alternative silvicultural practices and green tree retention practices on wildlife.

Objectives: To determine the relative influences of clearcutting and two uneven-age management approaches (group selection and two-story stands) on abundance and diversity of songbird populations in western Oregon.

Overview of approach and methods: This study is being conducted on the CFIRP research sites in Oregon State University's MacDonald-Dunn Forest. The CFIRP sites consist of sets of control stands and three silvicultural treatments (clearcut, two-story stands, and patch cuts) replicated in three blocks; patch cuts are a form of group selection where 1/3 of the stand's basal area was removed in 0.2-ha openings, two-story stands are similar to a form of green tree retention. Treatments for this study were implemented between 1989 and 1991. Response of bird populations to treatment during the first 2 years following treatment was studied by Chambers et al. (1999; *Ecological Applications* 9:171-185). Chambers et al.'s work is extremely valuable and provides the only available information on the influences of uneven-age forest management on songbirds in western Oregon, and some of the only information available on the implications of uneven-age management on birds in conifer systems anywhere. However, the management implications of their work are limited by the temporal limitations of their study. As structural development of these sites progresses, habitat conditions at the sites differ considerably from those at the time of treatment. For example, the patch cuts have developed considerable structural complexity in the ten years since the stands were harvested; this increased structural diversity may have important implications to songbirds that were not evident during the initial years following harvest. Our study is examining longer-term implications of these management approaches to songbirds, examining songbird response 11 to 14 years post-treatment. The combination of the work completed by Chambers et al., work in progress on the sites on small mammals by Waldien and Hayes, and results from this study will provide a solid base of understanding of the influences of these silvicultural approaches on wildlife.

Abundance of birds is being assessed during the breeding season using variable radius point counts. Point count stations were established in each stand, and each point is being visited a minimum of five times each year during the breeding season. Habitat assessments are being conducted during field seasons to assess the vegetative and structural characteristics of the stands, and these will be related to observed distributions and abundances of songbirds. Approaches to statistical analysis will be developed with assistance from the Department of Forest Science's Quantitative Sciences Group.

Progress: Two modifications to the design of the study described by Chambers et al. (1999) were made in 2002. Only a subset of previously established point count stations were used and new point count stations were established in some stands to ensure independence of variable circular plots. Also, only two randomly selected patch cut areas in each of three blocks (Peavy, Lewisburg Saddle, Dunn) were surveyed instead of conducting point counts in several contiguous small patch cut stands (defined by harvest boundaries) in each block. In the current study, two patch cut stands, two two-story stands, two modified clearcut stands, and one control stand were surveyed in each of the three blocks. All old and new point count stations locations were determined with a GPS and were recorded. Point counts were conducted from mid-May to early July 2002 and will be conducted during the same time frame in 2003. Habitat assessments were conducted in July 2002 and will be conducted during June-August 2003.

We conducted 6 point counts at each station between May 16 and July 5, 2002. A total of 5,522 bird detections representing 62 species were noted within all variable circular plots in all treatments. Among treatments, percentages of detections were comparable in the modified clearcut (33%), two-story (30%), and patch cuts (27%). Detections in the control stands represented 10% of total detections. Slightly fewer species were found in the control (46) than in the patch cut (54), two-story (57), or modified clearcut (56) stands. Species composition across treatments apparently differed (Figure 1). Some species, such as winter wrens, hermit warblers, and Pacific slope flycatchers were found more frequently in stands with mature forest (control and patch cut stands) whereas species such as house wrens and willow flycatchers were detected most frequently in stands with open habitat (modified clearcut and two-story stands). These trends are consistent with findings of Chambers, et al (1999) who found the bird communities in modified clearcut and two-story stands were similar, and bird communities in the control and patch cut stands were similar. Preliminary results from this study also showed high levels of detections of several species in patch cuts (e.g., red-breasted sapsucker, red-breasted nuthatch, and western tanager), suggesting development of understory in these stands since harvest may provide habitat for a broader suite of species than that which can be provided in unharvested control stands (Figure 1).

Timeline: Spring-summer 2003: Conduct second year bird surveys; complete habitat assessments.
Fall-winter 2003: Data management and data analysis.
Fall 2003-Spring 2004: Final data analysis and manuscript preparation.
Fall 2004: Publication of results.

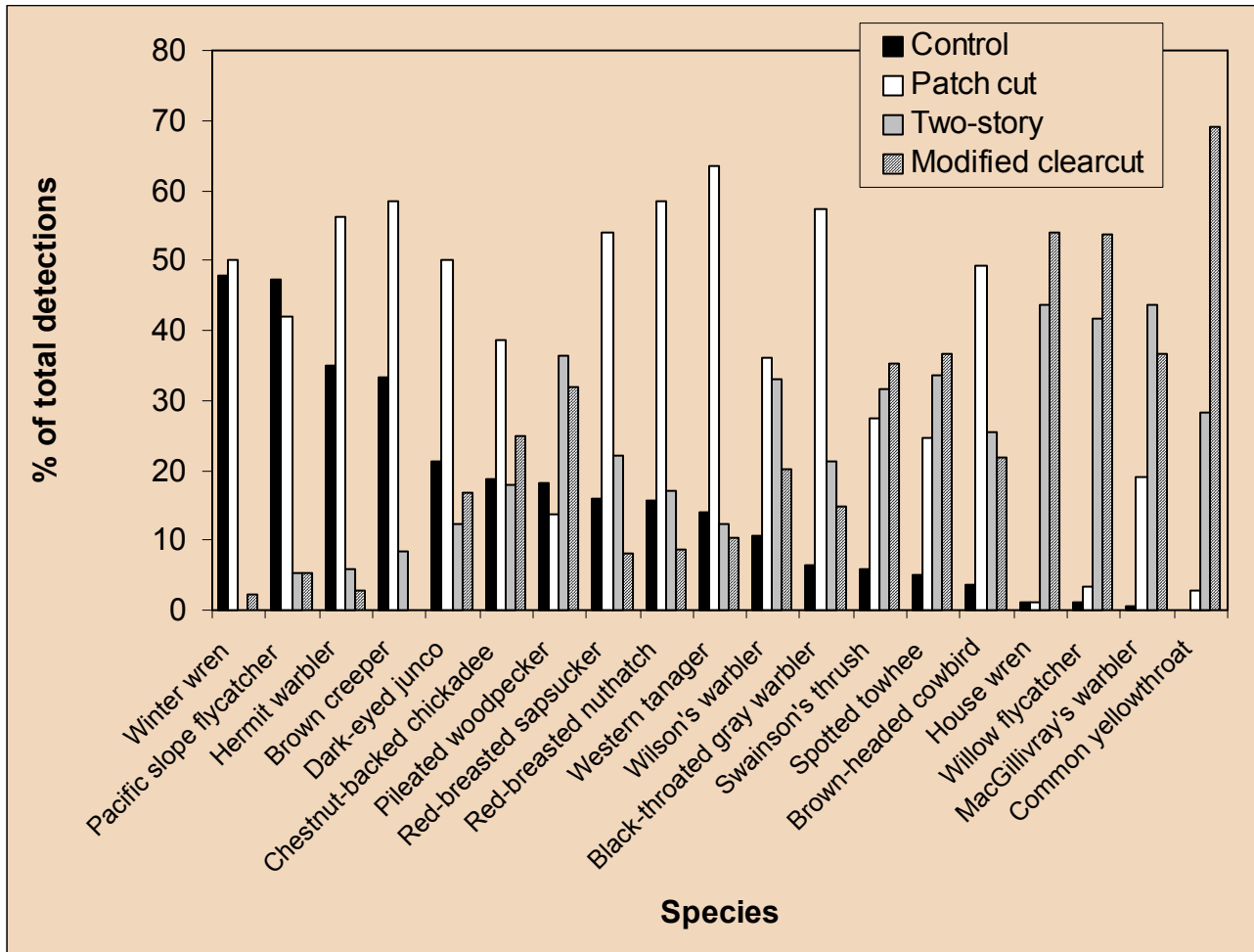


Figure 1. Percent of detections of each of 19 bird species in four silvicultural treatments in the McDonald-Dunn forest, May-July 2002. Species are representative of 62 species surveyed. Species on the left side of the chart were detected most frequently in stands with closed canopies (control and patch cut) and species on the right were detected most frequently in stands with more open habitat (two-story and modified clearcut).

Study 6: The Magnitude and Timing of Surface Runoff from Forest Roads Relative to Stream Flow in Live Stream Crossing Culverts in the Oak Creek Watershed (2001-2003)

Principal Investigator: Arne Skaugset, Forest Engineering Department, OSU
Elizabeth Toman, Graduate Research Assistant, Forest Engineering Department, OSU

Problem Statement: Since the listings of the coastal Coho salmon and other species and stocks of salmon as threatened or endangered, the environmental effects of forest management activities on aquatic habitat have come under increased scrutiny. Forest roads are a management activity that can have a deleterious effect on water quality and aquatic habitat for salmon and trout and thus has recently received increased scrutiny. Forest roads may change watershed hydrology by intercepting subsurface flow from hillslopes (Jones and Grant 1996) and they are chronic sources of fine sediment (Bilby et al 1989). While all roads interact with hillslopes and generate fine sediment at some level, the road segments that are directly connected to streams are the segments that are most likely to affect changes in watershed hydrology and have a deleterious effect on aquatic habitat (Wemple et al 1996).

Objective: To determine the magnitude and timing of surface runoff from forest roads connected to live streams and compare it to the magnitude and timing of streamflow in the receiving stream at the crossing.

Research Approach: For this project, the effect of the most common type of road/stream connectivity on the magnitude and timing of stream flow in the receiving stream at the stream crossing will be investigated. This type of connectivity is when a road crosses a stream at a midslope location and at approximately right angles to the stream. Depending on the grade of the road at the stream crossing, there will be either one or two road ditches that will contribute surface runoff and thus, sediment, directly to the stream at the culvert. The purpose of this project is to instrument and monitor several of these live stream crossing culverts in the Oak Creek watershed in the College of Forestry's school forest: the McDonald-Dunn Research Forest.

The primary equipment used will be capacitance rods and trapezoidal flumes. Capacitance rods will be installed at the inlet of the live stream crossing culverts to measure and record water level. Trapezoidal flumes will be placed in the road ditches that flow into the stream crossing culverts and water level will be measured and recorded with capacitance rods in these structures also. Raingages will be installed throughout the watershed to monitor rainfall. With this instrumentation, the timing and magnitude of the flows in the road ditches can be compared with the timing and magnitude of the flows in the stream at the live stream crossing culvert installation. Instrumentation for this project is being supported by a grant from the National Council for Air and Stream Improvement (NCASI).

Research Accomplishments: With this project, the research infrastructure within the Oak Creek watershed as well as the database infrastructure continues to grow. A digital elevation map made from LIDAR imagery is being used as a base map for this project. The topographic details of the Oak Creek watershed, including the watershed boundary, have been delineated down to the Oak Creek gauging station the Forest boundary. This area is now being referred to as the Oak Creek headwaters. The Oak Creek headwaters has an area of 824 hectares. There are 4,877 meters of stream and 4,572 meters of road in the watershed that results in a stream density of 5.92 m/ha and a road density of 5.55 m/ha. There are 98 road drainage structures on the roads within the watersheds. Of these, 22 are live stream crossing culverts and the remaining 76 are drainage relief or cross drain culverts.

During the winters of 2001-02 and 2002-03, a capacitance rod or crest gauge was installed to measure water height at every drainage structure in the watershed. Capacitance rods were installed on all of the live crossing culverts and these instruments collected a value of water height every 10 minutes. During the winter of 2001-02, five trapezoidal flumes were installed in roadside ditches above four of the stream crossing culverts. During the summer of 2002 an additional 12 trapezoidal flumes were installed, thus during the winter of 2002-03, 16 of the 22 live stream crossing culverts were instrumented with flumes measuring surface road runoff into the stream at that crossing. Water level in the trapezoidal flumes was also measured using capacitance rods. Water level and temperature data from the capacitance rods at the culverts and in the flumes were downloaded and stored monthly.

There was one rain gage located by the watershed outlet during the winter of 2001-2002. For the winter of 2002-03, four additional tipping bucket rain gages were installed and all three are located at the higher elevations in the watershed. Rainfall data is also downloaded and stored monthly.

One area of work that requires continuing effort is the establishment of stage-discharge relationships that allow the water level measurements from the capacitance rods and crest gauges to be converted to discharge values. Data gathering efforts have continued for this task on three fronts. First of all, during the summer of 2002 empirical stage-discharge relationships for seven culverts were developed by pumping water from Oak Creek into the roadside ditch, through a flume, and then through instrumented culvert. A second data gathering effort consisted of measuring discharge from the culverts during storms using a 5-gallon bucket and a stopwatch. Both of these methods confined the data gathering to discharges less than 5 to 7 l/sec. To get stage-discharge values for discharges greater than 5-7 l/sec, tracer slug tests have been used for flows through the culverts during storm flows. A database of over 50 data points that includes different culverts and a range of flows now exist. Some of these relationships are being used for preliminary analysis. Analysis of the larger stage-discharge relationship database will be carried out this spring and summer. Development and refinement of this dataset will continue into the foreseeable future.

Some preliminary analysis has been carried out for two live stream crossing culverts on the east flank of Oak Creek on the 600 Road. The areas of the watersheds that drain into the two stream crossing culverts are 2.2 and 3.3 hectares independent of the areas that might be included because of the roads. The lengths of the roads draining down into the stream crossing culverts are both approximately 100 meters. The estimated road runoff and stream flow from these two installations for a single storm during the winter of 2002-03 is shown in Figures 1 and 2. The hydrographs in Figure 1 and 2 show precipitation for the December 2002 storm, the stream flow from sub-basins, and the surface runoff from the road in the ditch. The two stream crossing culverts are on the same road, only about 300 meters apart, and have similar contributing areas. While they appear to be similar topographically, when viewing the runoff hydrographs it is obvious that one culvert (Figure #2) has much more road surface runoff. In fact the runoff from the road ditch is greater than that coming from the natural stream. The data used to generate the hydrographs shown in Figures 1 & 2 come from the stream crossing culvert installations that are pictured in Figures 3 and 4, respectively.

Research Plans: During the spring and summer of 2003, this type of data analysis will continue for all of the instrumented live stream crossing culverts and for all of the storms that occurred during the study period. These data and their analysis will constitute the content of an M.S. thesis for Elizabeth Toman. Elizabeth should be completed by the end of the summer 2003.

Data collection for this project should continue for at least one more winter and hopefully for several more years pending the availability of resource. This project is only one of several projects that are ongoing in Oak Creek and sharing this common dataset.

Project Duration:

Project Initiated: 2001
Project to be Terminated: 2003

References:

Bilby, R. E., K. Sullivan and S. H. Duncan. 1989. The generation and fate of road-surface sediment in forested watershed in southwestern Washington. *Forest Science* Vol. 35, No. 2, pp. 453-468.

Jones, J. A. and G. E. Grant. 1996. Peak flow responses to clear-cutting and roads in small and large basins, western Cascades, Oregon. *WRR* 32(4):959-974.

Wemple, B. C., J. A. Jones, and G. E. Grant. 1996. Channel network extension by logging roads in two basins, western Cascades, Oregon. *Journal of the American Water Resources Assoc.* 32(6):1195.

Figure 1. Storm Hydrograph for a Stream Crossing Culvert Installation (#1)

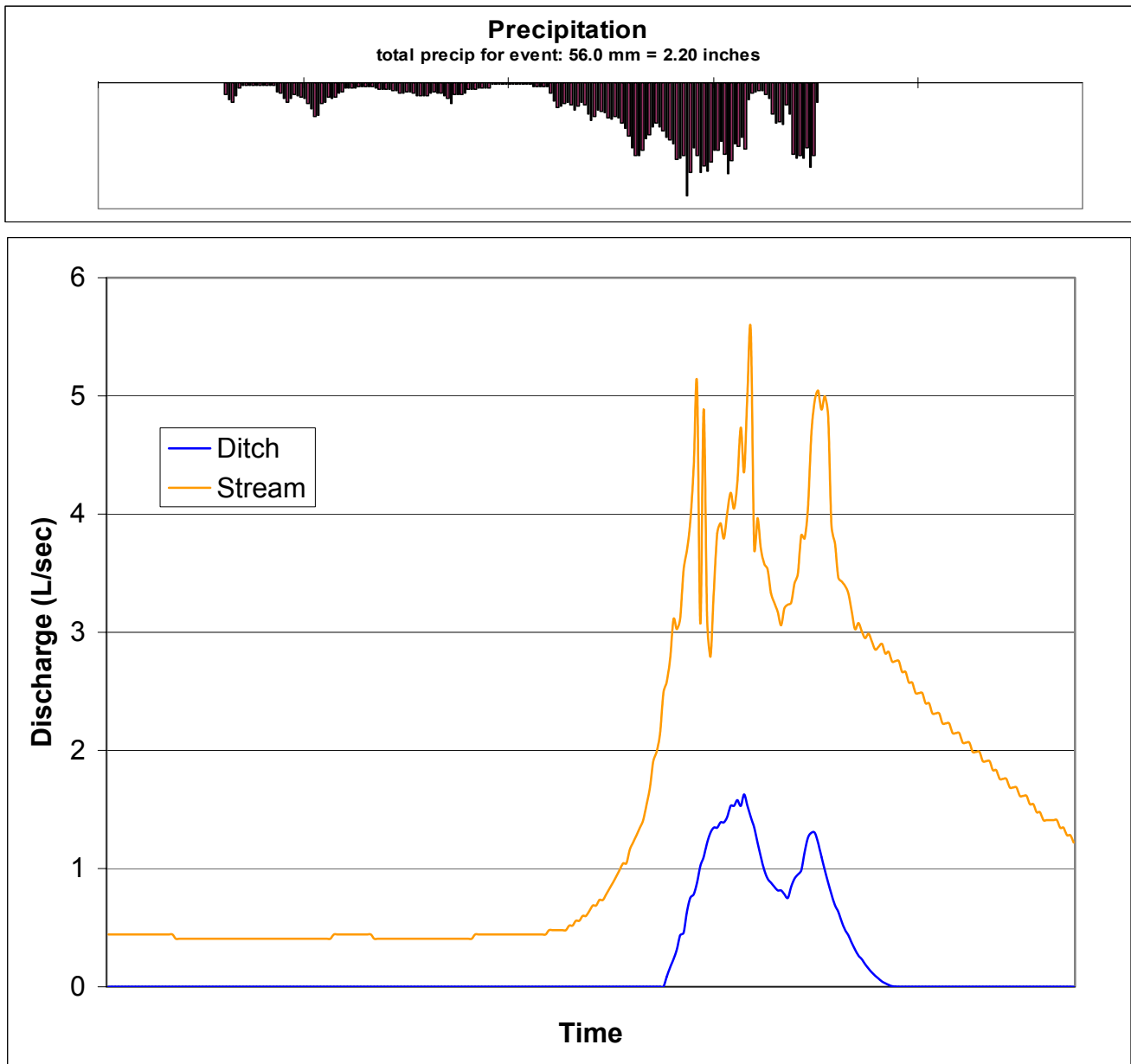


Figure 2. Storm Hydrograph for a Stream Crossing Culvert Installation (#2)

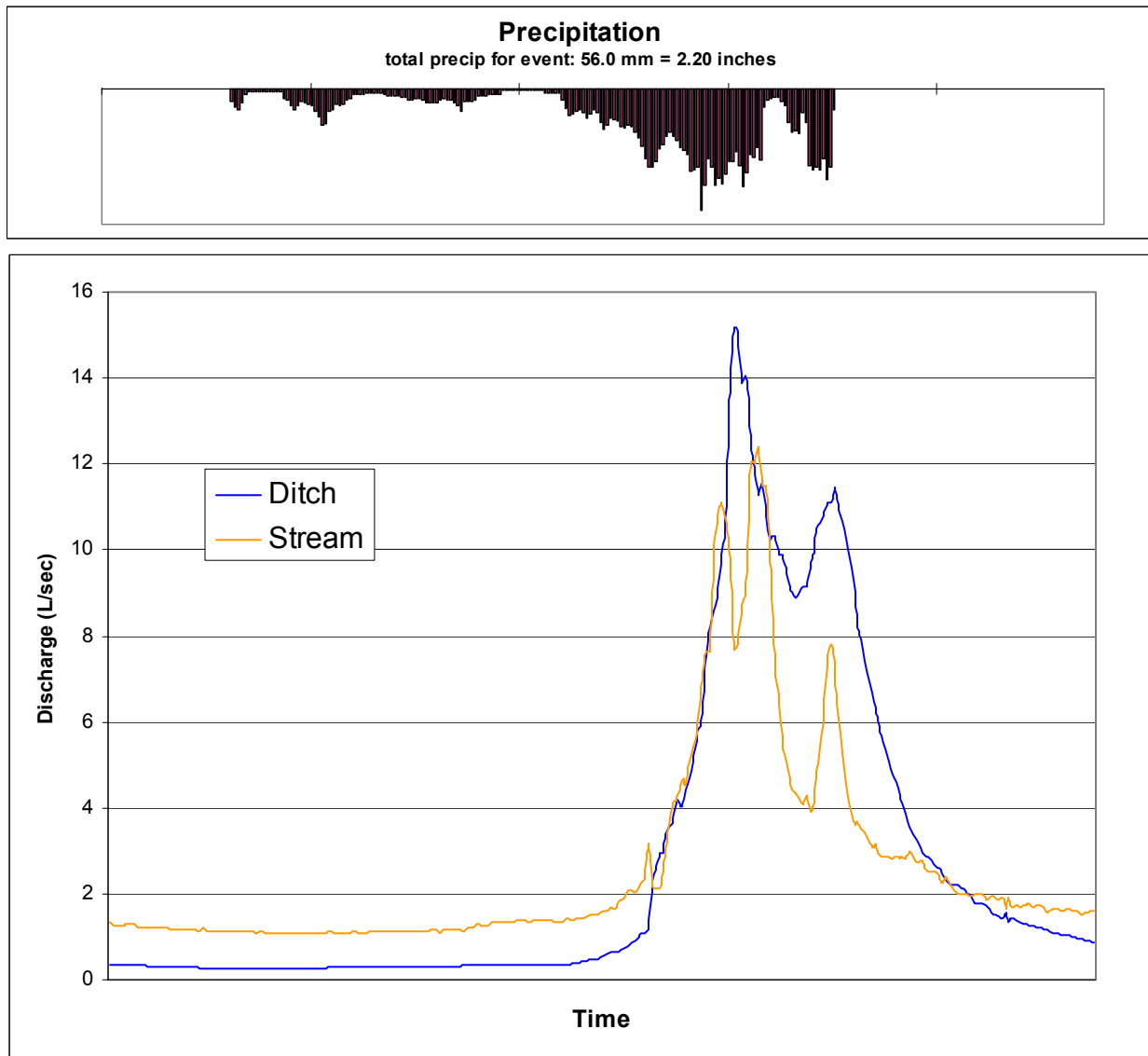


Figure 3. Pictures of Stream Crossing Culvert Installation (#1)



Figure 4. Pictures of Stream Crossing Culvert Installation (#2)



CALL FOR PROPOSALS FOR NEW PROJECTS TO BE FUNDED BY THE OSU FOREST RESEARCH LABORATORY FISH AND WILDLIFE HABITAT IN MANAGED FORESTS PROGRAM IN FY 2004

Several projects will be ending in this program during FY2003 and more than \$100,000 will be available to fund new work in FY2004, which begins on July 1, 2003. We are requesting one-page prospectuses from faculty that address issues relevant to the mission of this Program. The prospectuses will be reviewed by the technical advisory committee for the program on March 7, and recommendations for priorities of funding will be forwarded to the Department Heads administering the program and then on to the Dean for final decisions. Please complete the prospectus and return it to Steve Tesch, the Program Manager for this effort, by February 21, 2003 so that materials can be mailed to the advisory committee members prior to the March 7 meeting.

Please include the following information in the one-page prospectus:

Title

Names of investigators

Relevance of topic to program mission

Objectives

Basic overview of approach/methods

Timeline

Budget (scope budget for duration of project, present budget for FY2004)

For further information on prospectuses or the FRL Fish and Wildlife Habitat in Managed Forests program, contact Steve Tesch, Tom Adams, or Jack Walstad.

FY 2004

Program Planning

Ad hoc input from the program advisory committee (TAC) was solicited in during late fall and early winter to identify priority topics that could be potentially developed into research projects. Steve Tesch, Jack Walstad, Tom Adams, and Steve Hobbs consolidated the input into four categories:

1. Effects of land management practices on hydrologic functions, and on aquatic and riparian habitats.
2. Influence of intensive management on wildlife habitat, including activities related to stand establishment, young stand culture, and thinning. Target species included ungulates and mature forest species such as owls and murrelets.
3. Effects of wildfire, salvage, and restoration activities on fish and wildlife habitat.
4. Implications of steep slope management and landslides on aquatic habitat.

These categories and some tentative topics for research activities were forwarded to selected faculty in the Forest Engineering, Forest Resources, and Forest Science Departments, along with an invitation to prepare prospectuses for potential funding in FY2004. Nine prospectuses were submitted covering three of the four major categories and they are presented for the TAC to consider and prioritize on March 7. A list of the prospectus titles and faculty investigators follows.

OSU Forest Research Laboratory
 Fish and Wildlife Habitat in Managed Forests Research Program
 Tentative Budget for FY2004
 July 1, 2003 – June 30, 2004

	Tentative Investment (w/o 33% overhead)			
	FY2003	FY2004 Request	FY2005 Tentative	FY2006
Continuing Projects and Activities				
Study 1: Snags and Reserved Green Trees: Mortality Rates and Primary Cavity Nester Use (2000-2003)	35,000	0	0	0
Study 2: Influence of Silvicultural Treatments and Manipulation of Downed Wood on Abundance and Demographics of Small Mammals (1999-2002) (Extension requested to 12/2003)	25,000	15,000	0	0
Study 3: The Role of Perennial, Non-Fish-Bearing Streams in the Temperature and Flow Regimes of Small, Fish-Bearing Headwater Streams During Summer in Western Oregon (2001-2004)	50,000	50,000	0	0
Study 4: Examining Linkages Between Multi-Scaled Riparian Data, Fish Habitat Characteristics and Coastal Cutthroat Trout (<i>Oncorhynchus clarki clarki</i>) Populations (2001-2003) (Extension requested to 9/2003)	47,000	6,800	0	0
Study 5: Influence of Alternative Silvicultural Practices on Songbirds (2001-2005)	44,000	33,000	3,000	0
Study 6: The Magnitude and Timing of Surface Runoff from Forest Roads Relative to Stream Flow in Live Stream Crossing Culverts in the Oak Creek Watershed (2001-2003)	16,000	0	0	0
Study 7: Forest Management Strategies in Hinkle Creek Watersheds: Evaluation of Baseline Seasonal Stream Water Nutrient Concentrations and Soil Resources (2002-2006)	44,000	46,000	38,000	0
Totals	\$261,000	\$150,800	\$41,000	

Projected FY2004 budget is \$349,000 \$262,400 spendable after o/h
 Continuing project obligations 150,800

Funds available for reallocation \$111,600 after o/h

Budget Requests for Potential New Projects

<u>Potential New Project</u>	FY2004	FY2005	FY2006	TOTAL
Mammal Use of Created Snags Chris C. Maguire, Department of Forest Science	\$33,000	\$50,000	\$15,200	\$98,200
Small Mammal Use of Stands under Variable-Density Management Regimes Chris C. Maguire and others, Department of Forest Science	\$28,350	\$42,450	\$28,750	\$99,550
Soil Disturbance, Runoff & Erosion After Post-Fire Salvage Harvesting in Central Oregon Paul W. Adams, Forest Engineering Department	\$27,176	\$27,176		\$54,352
Post-fire Management on the Timbered Rock Fire: Impacts on Revegetation and Sediment Delivery to Flat Creek Stephen H. Schoenholtz and others, Forest Engineering Department	\$43,000	\$42,000	\$40,000	\$125,000
Managed Forests and Their Role in Maintaining Water Quality in a Multi-landuse River Basin Stephen H. Schoenholtz, Department of Forest Engineering	\$40,000	\$40,000	\$40,000	\$120,000
Contributions of Riparian Vegetation to Terrestrial and Aquatic Food Chains: Contrasting Alder and Douglas-fir Riparian Forests Steven Perakis, USGS Forest and Rangeland Ecosystem Science Center and David Hibbs, Department of Forest Science	\$30,000	\$35,000	\$25,000	\$90,000
Modeling the Effect of Roads on the Hydrology of a Roded, Forested Watershed: The Oak Creek Watershed Dr. Arne E. Skaugset III, Department of Forest Engineering	\$30,000	\$30,000		\$60,000
The Hinkle Creek Paired Watershed Study: The Effect of Timber Harvesting Adjacent to Non-Fish-Bearing Headwater Streams on Cumulative Water Quality Effects in Fish Bearing Streams. Dr. Arne Skaugset and Stephen Schoenholtz, Department of Forest Engineering	\$50,000	\$50,000	\$50,000	\$150,000
Habitat conservation for Stream Amphibians in a Managed Forest Landscape Michael J. Adams and John P. Hayes, and Department of Forest Science	\$39,600	\$41,600	\$43,700	FY07 \$45,800 FY08 \$6,000

Prospectuses for
Potential New Projects
For FY2004

FY2004
New Prospectuses

Forest Science

Mammal Use of Created Snags

Chris C. Maguire, Department of Forest Science

Contributions of Riparian Vegetation to Terrestrial and Aquatic Food Chains: Contrasting Alder and Douglas-fir Riparian Forests

Steven Perakis, USGS Forest and Rangeland Ecosystem Science Center, OSU and CFER program, David Hibbs, OSU Forest Science Department & CFER program

Forest Engineering

Soil Disturbance, Runoff & Erosion After Post-Fire Salvage Harvesting in Central Oregon

Paul W. Adams, Professor & Forest Watershed Extension Specialist

Post-fire Management on the Timbered Rock Fire: Impacts on Revegetation and Sediment Delivery to Flat Creek

Stephen H. Schoenholtz, Associate Professor, Department of Forest Engineering, Klaus Puettmann, Associate Professor, Department of Forest Science, John Tappeiner, II, Professor, Department of Forest Resources

Managed Forests and Their Role in Maintaining Water Quality in a Multi-landuse River Basin

Stephen H. Schoenholtz, Associate Professor, Department of Forest Engineering

Modeling the Effect of Roads on the Hydrology of a Roaded, Forested Watershed: The Oak Creek Watershed

Dr. Arne E. Skaugset III, Department of Forest Engineering, OSU

The Hinkle Creek Paired Watershed Study: The Effect of Timber Harvesting Adjacent to Non-Fish-Bearing Headwater Streams on Cumulative Water Quality Effects in Fish Be

Title: Mammal Use of Created Snags

Principal Investigator: Chris C. Maguire, Department of Forest Science

Relevance of Topic to Program Mission: Snags are important structural components of forest ecosystems for a variety of wildlife species. Consequently, the number and dimensions of snags to retain or create during harvest operations are stipulated for many forest systems. Snag density targets, however, are based on the presumed nest needs of avian primary cavity nesters and the assumption that these snag retention levels will naturally provide the snag requisites of all other snag-utilizing wildlife species. Regrettably, insufficient field evidence is available to evaluate the credibility of this assumption. Even more notable is our overall lack of understanding of the intensity of snag use by non-avian species, the important first bit of knowledge necessary to evaluate snag use overlap among diverse species and to justify snag retention targets in a biologically inclusive context across multiple management regimes.

Objectives: (1) To quantify and compare mammal use of snags under two snag distributions and three managed forest conditions. (2) To examine multi-taxa vertebrate use of a common snag resource.

Basic Overview of Approach and Methods: A common criticism directed at wildlife research is the general lack of experimental field studies. Although the predominance of observational wildlife studies are the justifiable result of many factors, more experimental studies are necessary to drive our knowledge of wildlife populations/communities forward more rapidly. The College of Forestry Integrated Research Project (CFIRP) in McDonald-Dunn Forest was established in the 1980s to experimentally address ecosystem consequences of several silvicultural treatments and two snag distributions. The 30 replicated/blocked units comprising CFIRP provide an ideal setting for evaluating mammalian use of snags for several reasons. (1) In excess of 1000 snags were created in two patterns (scattered and clumped) across all CFIRP units over one decade ago thereby providing a large snag sample size for assessing mammal use in a well-designed experimental setting that controls for snag distribution and stand condition. (2) Since their creation, snags have been examined three times for avian use, most recently in 2002. Information on mammal snag use can be coupled with the avian data to assess multi-taxa use of a common snag resource. (3) The three CFIRP silvicultural treatments (clearcuts with green-tree retention, thinning to generate two-story stands, group selection harvest) provide a range of managed forest conditions in which to evaluate snag utilization.

A range of mammal species will be targeted for evaluation by affixing a combination of large and small boxtraps to a standardized number of snags in six stands in each of three blocks that represent unique combinations of the three silvicultural treatments and the two snag distributions. Traps will be checked during spring 2004 for a minimum of two-weeks at each unit. Time permitting (largely based on trap success rates), the trapping period may be extended to four weeks. Additional supportive habitat measures will be taken to accurately describe habitat conditions across units.

Timeline:

- Fall 2003: Identify snags for study
- Winter 2004: Affix traps to snags
- Spring 2004: Conduct trapping
- Summer 2004: Gather habitat information
- Fall 2004 through Summer 2005: Analyze data; prepare and submit manuscripts

Budget:

FY 2004 - \$33,000; FY 2005 - \$50,000; FY 2006 - \$15,200; Total - \$98,200

FY 2004 (Oct 2003 - June 2004)

Maguire 0.15 FTE and benefits	\$13,000
FRA (Manning) 0.25 FTE and benefits	\$15,000
Transportation and mileage	\$ 2,000
Supplies	\$ 3,000
Total	\$33,000

FY 2005 (July 2004 - June 2005)

Maguire 0.2 FTE and benefits	\$16,500
FRA (Manning) 0.5 FTE and benefits	\$30,000
Transportation and mileage	\$ 1,000
Meeting travel	\$ 1,500
Supplies	\$ 1,000
Total	\$50,000

FY 2006 (July 2005 - Sept 2005)

Maguire 0.05 FTE and benefits	\$ 4,200
FRA (Manning) 0.125 FTE and benefits	\$ 7,500
Meeting travel	\$ 1,500
Publication costs	\$ 2,000
Total	\$15,200
Grand Total	\$98,200

Title: Small Mammal Use of Stands under Variable-Density Management Regimes

Principal Investigators: Chris C. Maguire, Mike Newton, Liz Cole (Department of Forest Science)

Relevance of Topic To Program Mission: It is commonly observed that faunal communities inhabiting diverse, multi-storied old-growth forests are themselves more diverse than those observed in single-age, single-storied, structurally simple younger stands that classically have been created from artificial regeneration of Douglas-fir on clearcuts. With increasing emphasis on managing forests for not only timber sustainability but also biological sustainability, the challenge is to develop silvicultural strategies that will enable forest managers to produce wood from these young stands while simultaneously providing complex habitat for wildlife. Although we have the silvicultural tools to generate stands possessing a variety of structural attributes, the question that remains largely unanswered is “If you build it, will they come?”

Objective: To quantify and compare small mammal use of stands managed under two tree density regimes, two tree distribution patterns, and three understory treatments.

Basic Overview of Approach and Methods: Small mammals are critical components of forest ecosystems as insect predators, vertebrate prey, dispersers of ectomycorrhizal fungi, seed and seedling predators, and seed dispersers, to name just a few of their most obvious ecological roles. They also have relatively small home ranges, a high level of habitat selectivity, and rapid turnover rates, plus high trappability of many species, characteristics that in combination make them ideal subjects for the study of habitat use versus availability in patchy forest landscapes.

The Stand Density Regulation and Understory Regeneration Project (SDR&URP) on McDonald-Dunn Forest provides a highly controlled replicated, experimental setting in which to undertake small mammal habitat use studies. To date this study has documented stand conditions from the time of conifer establishment in the understory immediately following four thinning intensities of 50-60 year old Douglas-fir stands, and monitored changes over time in both over- and understory densities and growth rates under four vegetation management and tree distribution patterns. It is now appropriate to overlap a wildlife study on this project to evaluate small mammal responses to changes in the vegetation structure that have resulted from the various vegetation treatment combinations.

Basic Overview of Approach and Methods: SDR&URP study stands are divided into three blocks; each block contains either random or clumped trees under four overstory density regimes for a total of eight 3.6 ac treatment combinations per block (N = 24). Each of three 1.2 ac understory treatment subplots are contained within each overstory treatment combination (N = 72).

Initial and current tree density regimes include:

Initial:	75-85 ft ² BA/ac	Current:	95 ft ² BA/ac
	95-105 ft ² BA/ac		95 ft ² BA/ac (re-thinned)
	115-125 ft ² BA/ac		115 ft ² BA/ac (re-thinned)
	130-140 ft ² BA/ac		150-160 ft ² BA/ac

Understory treatments include:

- No tree planting; no vegetation control
- Planting; no vegetation control
- Planting; herbicide application

Small mammals will be live-trapped in fall 2004 (the period of greatest population stability) under all understory vegetation subplots for both tree distributions (random and clumped) at the lowest and highest current tree densities (N = 36). These treatment combinations will provide the greatest range in stand structural complexity over which to evaluate small mammal use. Because small mammals will have the home range capability to cover areas containing a variety of structural conditions, evaluation of their trapping locations will shed light on their preferential use of an array of structural combinations. Appropriate stand features necessary for habitat analysis will be measured.

Timeline: Fall 2003 - M.S. student begins studies
 Summer 2004 - Establish trapping grids; assist with habitat data collection
 Fall 2004 - Sample small mammal communities
 Winter 2004 through Spring 2005 - Analyze data
 Summer 2005 through Winter 2006 - Complete thesis; submit manuscripts

Budget: FY 2004 - \$28,350; FY 2005 - \$42,450; FY 2006 - \$28,750; Total - \$99,550

Estimated Budget

FY 2004 (Oct 2003 - June 2004)

Maguire 0.15 FTE and benefits	\$13,000
M.S. student 0.49 FTE and benefits (9 mos)	\$11,250
Field assistant (4 wks @ \$10/hr)	\$ 1,600
Transportation and mileage	\$ 500
Supplies	\$ 2,000
Total	\$28,350

FY 2005 (July 2004 - June 2005)

Maguire 0.2 FTE and benefits	\$16,500
FRA (Cole) 0.05 FTE and benefits	\$ 3,750
M.S. student 0.49 FTE and benefits	\$15,000
Field assistant (8 wks @ \$10/hr)	\$ 3,200
Transportation and mileage	\$ 2,000
Supplies	\$ 2,000
Total	\$42,450

FY 2006 (July 2005 - March 2006)

Maguire 0.15 FTE and benefits	\$13,000
M.S. student 0.49 FTE and benefits (9 mos)	\$11,250
Meeting travel	\$ 2,000
Supplies	\$ 500
Publication expenses	\$ 2,000
Total	\$28,750

Grand Total	\$99,550
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Title: Soil Disturbance, Runoff & Erosion After Post-Fire Salvage Harvesting in Central Oregon

Principal Investigator: Paul W. Adams, Professor & Forest Watershed Extension Specialist

Relevance to Program Mission: Major concerns have been raised about the potential impacts of post-fire salvage harvesting on soil and water resources, particularly fish habitat. These concerns have been central in legal appeals and other challenges to salvage operations on federal lands, and similar issues may emerge on state and private lands. There is limited research and other credible information documenting the soil and water effects of post-fire salvage in Oregon using current harvest technology and resource protection standards. Needs for such information will remain high as major fire hazards persist on extensive areas of federal forests in Oregon through the next decade.

Objectives: This project will evaluate salvage harvest effects on soil disturbance, runoff, erosion and stream sedimentation in selected portions of an operational salvage harvest. The data and knowledge gained will produce an objective assessment of whether concerns about watershed and aquatic habitat impacts are warranted for the types of sites and operations studied.

Basic Overview of Approach/Methods: The Deschutes National Forest has proposed a major salvage harvest operation (4,330 acres, 23.4 million bf) within the Eyerly Fire area burned in 2002. Ground-based (tractor), skyline, and helicopter yarding units are planned, with timber sales offered in fall 2003*. Located within the Metolius River basin, the area has outstanding aquatic and other resource values and also provides exceptional access and visibility for both research and education/demonstration activities to convey findings effectively to diverse audiences.

Data collection will focus on post-harvest soil compaction (penetrometer transects & some bulk density samples), disturbance (systematic qualitative samples & photo points), runoff (infiltration measurements), erosion and stream sedimentation (silt fences, rill/gully & debris fan tallies, photo points, snowmelt & storm event-based sampling). Site characteristics and the active harvest operations will be carefully noted and described to facilitate interpretation of the soil and water observations.

Timeline:

Summer & Fall 2003:	Pre-harvest planning & data collection (baseline site characteristics)
Fall 2003 to Spring 2004:	Monitoring & descriptive assessment of salvage harvest operations
Winter 2004 to Spring 2005:	Soil & water monitoring & data collection, analysis & interpretation
Spring 2005:	Prepare final project report

Budget: (annually for 2 years, FY2004-05)

Principal Investigator (0.05 FTE)	\$ 5,523 (salary + OPE)
Graduate Research Assistant (0.49 FTE)	\$ 17,153 (stipend + OPE)
Travel, Supplies & Services	<u>\$ 4,500</u>
Total	\$ 27,176

Title: Post-fire Management on the Timbered Rock Fire: Impacts on Revegetation and Sediment Delivery to Flat Creek

**Principal Investigators: Stephen H. Schoenholtz, Associate Professor, Department of Forest Engineering, Klaus Puettmann, Associate Professor, Department of Forest Science
John Tappeiner, II, Professor, Department of Forest Resources**

Collaborators: Bureau of Land Management, Boise Company.

Relevance to Program Mission: The proposed study is a response to the current controversy concerning salvage logging as a component of post-fire management. The Timbered Rock Fire burned approximately 27,000 acres in the Butte Falls Resource Area managed by the Oregon BLM (Medford District). The fire occurred within the Elk Creek Watershed in a mix of high elevation conifer (4,500 ft) and low elevation mixed conifer/hardwood (2,000 ft) with varying degrees of intensity in July 2002. It burned across a mixed ownership of federal, private, and industrial forestlands. Federal lands administered by the BLM and USFS within the Elk Creek Watershed are designated late-successional reserve and the watershed supports anadromous salmonids including coho and summer and winter steelhead fish species.

The fire damaged approximately 100 MMBF of standing timber on BLM-administered lands. Economic recovery of fire-killed trees is considered a potential resource recovery opportunity for this fire. Preliminary estimates indicate between 15-40 MMBF may be available for economic recovery. However, salvage logging has become a controversial post-fire management activity in part because of its potential to cause additional site disturbance and subsequent acceleration of soil erosion. The occurrence of this fire provides an opportunity to study effects of salvage activities on revegetation dynamics, soil erosion, and sediment delivery to streams supporting anadromous salmonid species.

Objectives:

- Investigate the effects of post-fire salvage logging on occurrence of sediment delivery to fish-bearing streams.
- Determine if there are salvage logging activities and/or site characteristics that are related to occurrences of sediment delivery.
- Evaluate the effects of post-fire salvage logging on natural plant succession during the first three years after the fire.

Approach: Our approach will consist of an evaluation of the frequency and characteristics of areas that show evidence of sediment delivery into Flat Creek, a perennial tributary of Elk Creek that supports anadromous salmonid species and is centrally located within a burned area of the Timbered Rock Fire with significant merchantable timber. A survey of site characteristics adjacent to areas of sediment delivery, including presence and method of salvage logging, level of soil disturbance, contributing area, slope gradient and length, geomorphology, soil characteristics, and vegetation cover and density will be conducted in order to explore interactions between post-fire conditions and sediment delivery to Flat Creek.

We expect that most sites on the Timbered Rock Fire will initially be vegetated by forbs and shrub seedlings (e.g., *Ceanothus* spp. and *Arctostaphylos* spp.) and that a dense cover of shrubs will develop quickly (within three years of the fire). As part of our assessment of site characteristics related to sediment delivery, we will be able to explore if shrub and forb cover is affected by

variables such as degree of disturbance during logging, slope and aspect, or amount of tree cover left standing.

The outcome of this three-year study will contribute to our understanding of the impacts of salvage logging on 1) degree of soil disturbance, 2) soil erosion and sediment delivery to streams, and 3) natural plant succession in an area of Oregon that has historically been subjected to many wildfires and will continue to present challenges for post-fire management decisions that balance economic, social, and environmental interests.

Timeline: Spring 2003 - recruit new graduate student; Summer/Fall 2003 – develop study plan, locate sampling sites, initiate sampling; Winter/Spring/Summer/Fall 2004 – continue sampling, initiate data analysis; Winter/Spring/Summer/Fall 2005 – complete sampling and data analyses; Winter/Spring/Summer/Fall 2006 – finish thesis/dissertation, submit final report, write manuscripts based on thesis/dissertation results.

Proposed Budget:

A graduate research assistant will be recruited specifically for this project.

<u>FY 2003-04</u>	<u>FY2004-05</u>	<u>FY2005-06</u>	<u>Total</u>
\$43,000	\$42,000	\$40,000	\$125,000

Title: Managed Forests and Their Role in Maintaining Water Quality in a Multi-landuse River Basin

Principal Investigator: Stephen H. Schoenholtz, Associate Professor, Department of Forest Engineering

Collaborators: USDA ARS, USDA NRCS, US EPA, OSU Department of Fisheries and Wildlife, Oregon DEQ, Calapooia Watershed Council, Weyerhaeuser Company, and Willamette National Forest.

Relevance to Program Mission: The Calapooia River is a tributary of the Willamette River that flows 65 miles from headwaters in the west-central Cascade Range to its confluence with the Willamette River near Albany. The headwaters of the Calapooia are forested and occur within the Willamette National Forest. The river then flows through land predominately occupied by industrial forestry landowners, which is subjected to intensive, contemporary forest management designed to provide a long-term source of wood while sustaining soil and water resources and long-term productivity. As the river flows into the Willamette Valley, land use changes from forest management to agriculture, with a primary emphasis on production of grass seed.

Winter steelhead and cutthroat trout occur in the Calapooia River. However, the river is 303(d)-listed for impaired water quality because of dissolved oxygen, temperature, and fecal coliform levels that do not comply with federal and state water quality standards. The success of eliminating impairment of water quality for rivers such as the Calapooia depends on availability of scientific information specific for the river, including data on water quality in relation to land use within the watershed, and the role of the riparian zone which functions as the interface between terrestrial processes and aquatic properties and processes. The multiple land use types within the Calapooia Watershed offer an outstanding opportunity to evaluate the role of contemporary forest management regarding water quality in relation to other types of land management within the river basin.

Although investigations of riparian function in relation to nitrogen and phosphorus dynamics have occurred and are ongoing within the Willamette Valley, research to date in the Calapooia watershed has focused exclusively within an agricultural setting. Thus, there is a lack of information that integrates the relative role of different land uses within this multi-landuse basin, where contemporary forest management plays a significant role. This project will assess riparian function and water quality in both agricultural and forestry settings in order to help promote basin-wide natural resource management aimed to improve water quality and aquatic habitat in the Calapooia River.

Objectives:

- Evaluate the relative contribution of current forest management practices to water quality, with an emphasis on dissolved nitrogen and temperature, in the Calapooia River.
- Investigate relationships between land use and river water quality throughout the watershed.
- Contribute to development of integrated river basin management that will improve habitat for aquatic species, particularly winter steelhead and cutthroat trout.
- Collaborate with ongoing investigations within the watershed.

Approach: The above objectives will be achieved by assessing dissolved nitrogen and water temperature along the length of the river in relation to adjacent land use and riparian conditions. River water and groundwater samples collected at monthly intervals will be analyzed for total N, organic N, nitrate-N, and ammonium-N in the USDA-ARS laboratory on the Oregon State University campus. The USDA-ARS has agreed to provide laboratory analyses as in-kind support for this project. Nitrogen processes, including net mineralization/immobilization and denitrification

within the riparian zone will be assessed at monthly intervals in representative land use settings. Shallow groundwater wells will be installed to a depth of one meter in transects across the riparian zones under study and will be sampled monthly for depth of water table and dissolved nitrogen. Water temperature in relation to riparian zone characteristics (i.e., shade) and adjacent land use will also be explored through continuous direct measurements using recording temperature probes. A graduate research assistant will be recruited specifically for this project.

The outcome of this three-year investigation will contribute to our understanding of 1) the relative roles of riparian zones, in terms of dissolved nitrogen and water temperature, along a river continuum of land uses and 2) the relative role of active forest management within a multi-use river basin in terms of these two key water quality variables that influence aquatic habitat. This project is designed to integrate with ongoing research of water quality, aquatic habitat, and aquatic communities of macroinvertebrates and fishes being conducted by collaborators listed above.

Timeline: Spring 2003 - recruit new graduate student; Summer/Fall 2003 – develop study plan, locate sampling sites, initiate sampling; Winter/Spring/Summer/Fall 2004 – continue sampling, conduct laboratory analyses, initiate data analysis; Winter/Spring/Summer/Fall 2005 – complete sampling, lab and data analyses; Winter/Spring/Summer/Fall 2006 – finish thesis/dissertation, submit final report, write manuscripts based on thesis/dissertation results.

Budget:	<u>FY 2003-04</u>	<u>FY2004-05</u>	<u>FY2005-06</u>
	\$40,000	\$40,000	\$40,000

**Title: Contributions of Riparian Vegetation to Terrestrial and Aquatic Food Chains:
Contrasting Alder and Douglas-fir Riparian Forests**

Principal Investigators: Steven Perakis, USGS Forest and Rangeland Ecosystem Science Center, OSU, & CFER program, David Hibbs, OSU Forest Science Department & CFER program

Relevance to program mission: This research addresses the contribution of riparian vegetation to the nutritional needs of organisms in riparian terrestrial and aquatic food chains. It builds on ongoing CFER studies of riparian food chains by assessing the biological availability of different leaf litter types in both terrestrial and aquatic riparian environments.

Objectives: In both alder- and conifer-dominated riparian reaches, characterize

- 1) the biological availability of plant litter in both riparian forest and stream ecosystems
- 2) how stream and soil chemical characteristics further regulate biological availability of litter.

Overview: Vegetation plays many critical roles in the productivity of riparian terrestrial and aquatic habitats. Two roles have received much attention in previous studies: large wood and shade. While both of these issues are far from completely understood, enough understanding has been generated that they are being used as the basis for current and new riparian management regulations.

An ignored yet critical role of riparian vegetation is as a source of nutrition for riparian consumer organisms including insects, birds, bats, rodents, amphibians and fish. With the main exception of insects, however, only a few organisms feed directly on riparian vegetation. Instead, most organisms derive their nutrition from food chains, which are supported at their base by the breakdown and incorporation of leaf litter into fungi, insects, etc. In small headwater streams, riparian leaf litter inputs provide essential subsidies that fuel in-stream productivity of insects and fish. Leaf litter inputs can also be important in subsidizing food chains of terrestrial habitats. For example, our ongoing CFER research in coastal Oregon riparian zones indicates that the most abundant birds in these habitats feed primarily at the ground leaf litter surface.

Plant species vary greatly in the nutritional quality of their leaf litter, and these variations translate directly to differences in the timing and rates of leaf litter breakdown. Given the potentially critical role that riparian vegetation plays in subsidizing the productivity of terrestrial and aquatic riparian food chains, there is a risk that current riparian management strategies based solely on large wood and shade needs may be creating a new set of riparian problems, a new set of limiting conditions. Intuitively it makes sense to balance large wood and shade needs with the nutritional values provided by riparian vegetation, yet information on the nutrition role is sorely lacking.

The CFER program has initiated a large, multi-year program to address this nutritional issue. It has ongoing studies to examine how vegetation composition and physical characteristics of riparian zones influences the delivery of leaf litter to riparian soils and streams in both alder- and conifer-dominated riparian systems. This information is being related to the diets and fitness of birds, bats, insect, amphibians and fish. In all cases, the association with the vegetation is through correlation with the abundance of different vegetation types. A critical connection missing in this study is a direct measure of the availability of different plant-derived nutritional food sources in both riparian forest and aquatic environments. We propose here to do that study.

Approach: The CFER riparian food chain study has for one year examined a series of sites within the Coast Range located in the Nestucca, Alsea, and Siuslaw drainages. We propose to focus this work on those reaches where studies are currently examining the magnitude and timing of vertical

and lateral leaf litter inputs to riparian soils and streams. Most of these sites overlap with reaches being used for the aquatic insect and amphibian studies.

The rate of leaf litter breakdown (measured as the loss of mass and specific biochemical compounds) provides an integrative measure of the nutritional quality of different leaf litters in terrestrial and aquatic food chains. We propose to measure seasonal rates of alder and conifer leaf litter breakdown in riparian soil and stream environments to determine differences in these two important litter types. We will compare rates of alder vs. conifer breakdown in both terrestrial and aquatic habitats, and in alder vs. conifer dominated riparian zones. Direct biochemical measures of litter nutritional quality (lignin:nitrogen ratio) during breakdown will also be assessed in order to understand the cause for differences among plant species and habitats. Finally, since the nitrogen concentration of the surrounding soil and stream water environment can affect litter breakdown, we will contrast results for nitrogen rich vs. nitrogen poor areas of the Coast Range. Areas of contrasting nitrogen richness will be selected on the basis of historic and contemporary alder abundance using aerial photos, with direct measurement of soil and stream water nitrogen concentrations at the sites chosen for decomposition experiments. This will support one master's student project.

Time line: Fall/winter 2003/4: develop study plan. Spring/summer 2004: field collections and beginning lab analysis. Fall 2004: lab analysis. Winter/spring/summer 2005: data analysis and reporting.

Budget: FY04: \$30,000 **FY05:** \$35,000 **FY06:** \$25,000

Title: Modeling the Effect of Roads on the Hydrology of a Roaded, Forested Watershed: The Oak Creek Watershed.

Principal Investigator: Dr. Arne E. Skaugset III, Department of Forest Engineering, OSU

Relevance of the Topic to the Program Mission: With the listing of several salmonid species in the last decade as threatened or endangered, concern regarding the environmental effects of intensive forest management, especially timber harvesting activities, has increasingly focused on fisheries and aquatic habitat. A timber harvesting activity that has come under increased scrutiny in recent years is forest roads. Forest roads are directly connected to stream systems at live stream crossing culverts. This connectivity is hypothesized to result in an increase in the drainage density of the watershed. The increased drainage density is hypothesized to cause the watershed to be more hydraulically efficient, which results in increased peak flows. There is a general belief that one of the environmental impacts of forestry is the overall change in watershed hydrology caused by the presence of the roads and the resulting change in the routing of hillslope water and it is generally believed to have a deleterious effect of fisheries.

It is not possible to determine the effect of roads in a straightforward-paired watershed approach because there are no unroaded watersheds being developed on a large scale at present. Thus, a research approach is to study the hydrology of roaded watersheds and then using a process level, distributed hydrologic model, investigate the effects of the road through the model. This is proposed for the Oak Creek Watershed because an extensive and spatially distributed dataset for the hydrology of the roads and the watershed is available.

Objectives:

- To model the rainfall-runoff hydrology of the Oak Creek watershed and the roads in the Oak Creek Watershed using DHSVM.
- To investigate other modeling approaches that will allow the effect roads on the hydrology of roaded watersheds to be studied.

Methods: On the Oak Creek Watershed within the McDonald/Dunn Research Forest, intensive data has been collected on the hydrology of the roads within the watershed. There are 98 drainage structures on the roads in Oak Creek. Approximately 22 of these structures are live stream crossing culverts and the rest of them are cross drain culverts. For the last two winters, a capacitance rod or crest gauge was installed at every drainage structure in the watershed and at the mouth of the watershed. Also, 16 trapezoidal flumes have been installed in the road ditches that drain into the live streams. Thus, a detailed and spatially distributed record of the hydrology of the road and the watershed exists. Analysis of these data to date has consisted mainly of trying to understand how the roads affect runoff processes at individual sites. The approach for this project is to put all of the data together and see if the combination of a spatially distributed dataset of road runoff in combination with a spatially distributed hydrologic model can help inform us relative to the effects of roads on watershed hydrology. The model that is proposed for use is DHSVM (Distributed Hydrology - Soil and Vegetation Model). However, once DHSVM has been investigated fully, other appropriate models should also be investigated.

Timeline: A two-year timeline is proposed.

Project Initiated	FY 2004
Project Terminated	FY 2006

Budget: The budget will support a post-doc for approximately 2 years.

FY 04: \$ 30,000 FY 05: \$ 30,000

Title: The Hinkle Creek Paired Watershed Study: The Effect of Timber Harvesting Adjacent to Non-Fish-Bearing Headwater Streams on Cumulative Water Quality Effects in Fish Bearing Streams.

Principal Investigators: Dr. Arne E. Skaugset III and Stephen H. Schoenholtz, Department of Forest Engineering, OSU

Relevance of topic to program mission: With the listing of several salmonid species in the last decade as threatened or endangered, concern regarding the environmental effects of intensive forest management, especially timber harvesting, has increasingly focused on fisheries and aquatic habitat. However, contemporary forest practice rules are more progressive and restrictive than ever and are specifically designed to protect fisheries and aquatic habitat during timber harvesting adjacent to fish-bearing streams. Thus, the concern has shifted away from large, fish-bearing streams and focused on focused on non-fish-bearing, headwater streams that receive less formal stream protection in the form of buffer strips. In other words, to some degree, the focus of the debate has shifted away from the question ‘How wide should buffer strips be?’ to ‘How long should buffer strips be?’

For harvesting activities adjacent to non-fish-bearing, headwater streams to affect fish and aquatic habitat downstream in fish-bearing streams, then the two streams must be connected by some direct physical link. Stream temperature and sediment are two water quality parameters associated with current forest practices that are hypothesized to be able to move off-site and affect downstream aquatic resources. The overall goal of this project is to investigate the cumulative watershed effects of harvesting adjacent to non-fish-bearing streams on stream temperature and sediment and determines how those cumulative effects impact downstream fisheries and aquatic habitat.

Objectives:

- To determine the on-site effects of harvesting adjacent to perennial, non-fish-bearing streams on stream temperature and accelerated erosion.
- To determine the cumulative effects of harvesting adjacent to several perennial, non-fish-bearing streams on stream temperature and accelerated erosion off-site in fish-bearing streams.
- To identify and quantify the hydrologic processes and the magnitude of the processes that are responsible for propagating stream temperature and sediment effects downstream.

Methods: The experimental approach for this project is a nested, paired watershed study. The paired watershed study will take place in the Hinkle Creek Watershed in southern Oregon. Hinkle Creek is located 25 miles east of Roseburg, Oregon in the foothills of the Cascades. The watershed is almost wholly owned by Roseburg Forest Products and supports a stand of 55-year old, harvest-regenerated Douglas fir. The forest stand is typical of the kind of forests and forestland that is currently owned and being managed by private, industrial, timberland owners in western Oregon for the production of solid wood products in perpetuity.

The main study watershed has an area of 5,000 acres that is pretty evenly divided into the North and South Forks. Roseburg Forest Products has set the North Fork aside for 10 years to act as a control. The South Fork will serve as the treated watershed in the paired watershed study. Within the North Fork and South Fork watersheds, six headwater watersheds, or small watersheds that are drained by perennial non-fish-bearing streams, will also be set up as a paired watershed study. Two of these

watersheds are in the North Fork and will act as controls and four small watersheds are located in the South Fork and will be treated. Discharge, suspended sediment, and temperature will be measured on each of the small perennial, non-fish-bearing streams as well as at the mouths of the North and South Forks of Hinkle Creek.

The treatment planned for the treated watershed(s) is to harvest timber using contemporary forest practices. For two of the study watersheds, current forest practices will be used to harvest the timber including the timber adjacent to the perennial, non-fish-bearing streams and no formal buffer strip will be prescribed. For the other two small, perennial, non-fish-bearing streams, a buffer strip composed of non-merchantable overstory material will be prescribed. The treatment prescribed for each study watershed will be randomly assigned. Timber harvest will occur starting during the summer of 2005.

A grant has been secured from the Oregon Watershed Enhancement Board that will allow purchase and installation of all of the hardware. Sufficient funds exist to get the project to the onset of winter rains this fall. At that time, resources will be needed monitor, maintain, and replace the equipment as needed, and collect, archive, and begin analysis of the data.

Timeline: A three-year timeline is being proposed. All equipment will be installed by fall 2003. Harvesting will occur during the summer 2005. The three-year timeline allows for two summers of calibration for temperature data and two winters of calibration for sediment. Then one year of post-treatment data once timber harvest occurs.

Project Initiated	FY 2004
Project Terminated	FY 2007

Budget: The budget will support approximately 0.5 FTE of a FRA for Hinkle Creek, travel, and office support in Roseburg. Travel includes in-state travel for data collection and out-of state travel to present research results in appropriate scientific outlets.

FY 04: \$ 50,000 **FY 05:** \$ 50,000 **FY 06:** \$ 50,000

Title: Habitat conservation for stream amphibians in a managed forest landscape.

Principal Investigators: Michael J. Adams and John P. Hayes, USGS FRESC and Department of Forest Science, OSU.

Relevance of topic to program mission: Although numerous studies have suggested negative effects of timber harvest on headwater stream amphibians in the Pacific Northwest, other studies show that stream amphibians remain common in many second- and third-growth forests. This apparent discrepancy may be a matter of scale and regional differences in timber harvest effects. We propose to investigate how forest management interacts with landform, surface geology, and other regional characteristics to influence distribution and abundance of stream amphibians in a multi-age forest landscape. This study will include participation in the Hinkle Creek paired watershed study where amphibians will be monitored before and after timber harvest on control and treatment plots. The proposed work will be an important step toward understanding the physical, biological, and management factors influencing distribution and abundance of stream amphibians in western Oregon. The work will build on previous work on amphibians in the Oregon Coast Range funded by the FRL Fish & Wildlife Habitat in Managed Forests Research Program.

Objectives:

1. To assess influences of forest management practices in the Hinkle Creek drainage on abundance and distribution of stream amphibians.
2. To test the efficacy of existing habitat association models for stream amphibians in the Oregon Cascades.
3. To develop forest management recommendations for stream amphibians.

Overview: The Hinkle Creek study will assess the effects of riparian tree retention on headwater streams. It will provide an unprecedented opportunity to examine within basin variability of stream conditions and stream organisms. Amphibians are not currently being examined in the Hinkle Creek study, but it would be highly desirable to add them to the study because of the important role they play in stream ecosystems and their indicator status. We will use data from Hinkle Creek to assess spatial and temporal variation in the distribution and abundance of stream amphibians, and the influences of forest management activities on stream amphibians. We will expand these results by also surveying stream amphibians throughout the Oregon Cascades to determine the ability of existing models to predict amphibian density.

Approach:

1. Monitor stream amphibians in North and South Forks of Hinkle Creek from 2004-2006. Six stands will be harvested in the South Fork in 2005 and we will analyze how stream amphibians respond spatially and numerically to the change in the forest mosaic.
2. Sample managed forests in Oregon Cascades (non-wilderness FS lands, state lands, timber company lands). We will randomly chose stream reaches and relate stream amphibian density to landform, surface geology, substrate, and forest characteristics. Habitat associations of stream amphibians in the Oregon Cascades have not been previously studied.
3. Compare and synthesize models that predict stream amphibian density; produce region-specific recommendations for habitat conservation in managed forests. Increasing evidence suggests that the sensitivity of stream amphibians to timber harvest varies greatly among and even within regions. We will use a GIS to produce adaptive management recommendations.

Timeline: Field work would begin in Fall 2003, and continue during spring and fall 2004, 2005, and spring 2006. Data analysis and reporting will take place in 2006 and 2007, with final publications published in 2008.

Budget:

FY04: \$39600 FY05: \$41600 FY06: \$43700 FY07: \$45800 FY08: \$6000

TECHNICAL ADVISORY COMMITTEE

FRL FISH AND WILDLIFE HABITAT IN MANAGED FORESTS
RESEARCH PROGRAM

Neil Armantrout
USDI Bureau of Land Management
P.O. Box 10226
Eugene, OR 97400
Phone: 541/683-6451
FAX: 541/683-6981
E-mail: narmantr@or.blm.gov

Tony Melchoirs
Weyerhaeuser Company
WTC 1A5
PO Box 9777
Federal Way, WA 98063-9777
Phone: 253/924-4972
Fax: 253/924-6736
E-mail: tony.melchoirs@weyerhaeuser.com

Mary Zuschlag
Siuslaw National Forest
Earth/Biological & Planning
USDA Forest Service
P.O. Box 1148
Corvallis, OR 97339
Phone: 541/750-7054
FAX: 541/750-7234
E-mail: mzuschlag@fs.fed.us

Larry Giustina (Chair)
Giustina Land & Timber Co.
P.O. Box 989
Eugene, OR 97440-0989
Phone: 541/345-2301
FAX: 541/345-2305
E-mail: larry@giustinaland.com

George Ice
NCASI, West Coast Regional Center
P.O. Box 458
Corvallis, OR 97339
Phone: 541/752-8801
FAX: 541/752-8806
E-mail: gice@wrc-ncasi.org

Larry Irwin
NCASI
P.O. Box 68
Stevensville, MT 59870
Phone: 406/777-7215
FAX: 406/777-7213
E-mail: liirwin@bitterroot.net

V.W. Kaczynski
8320 Cooper Spur Road
Parkdale, OR 97042
Phone: 541/352-4188
E-mail: Vickaczynski@gorge.net

Rosemary Mannix
Forest Biology Program Manager
Oregon Department of Forestry
2600 State Street
Salem, OR 97310
Phone: 503/945-7347
FAX: 503/945-7376
E-mail: RMANNIX@ODF.STATE.OR.US

Jon Germond
Oregon Department of Fish and Wildlife
P.O. Box 59
Portland, OR 97207
Phone: 503/872-5255, Ext. 5598
FAX: 503/872-5269
Jon.P.Germond@state.or.us

Gary Springer
1060 SE Marion Avenue
Corvallis, OR 97333
Phone: 541/757-8665
E-mail: gtspringer@attbi.com

Chris Jarmer
Oregon Forest Industries Council (OFIC)
1201 Court Street NE Suite 300
Salem, OR 97301
E-mail: chris@ofic.com