FISH AND WILDLIFE HABITAT IN MANAGED FORESTS RESEARCH PROGRAM

PROGRAM OF RESEARCH

FY 2006
(July 1, 2005 - June 30, 2006)

College Of Forestry
Forest Research Laboratory
OREGON STATE UNIVERSITY
Corvallis, Oregon
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 FISH AND WILDLIFE HABITAT IN MANAGED FORESTS RESEARCH PROGRAM (F&W Program) was established on November 1, 1994, guided by recommendations from a Technical Advisory Committee comprised of fish and wildlife specialists and forest managers from government, industry, and non-industrial land owners to the FRL Director. The F&W Program is primarily conducted within the College of Forestry’s Forest Engineering, Forest Resources, and the Forest Science Departments, with strategic collaboration from scientists residing in other OSU units and federal agencies.

Based on the harvest level at the time, the F&W Program was initially funded with $457,485 in increased Harvest Tax revenues annually. Research, technology transfer, and service activities were selected by College program leaders based on advice received from the Technical Advisory Committee and in consultation with key faculty. When the F&W program was initiated in 1994, the overall FRL research program already included numerous research projects on fish and wildlife in managed forests. These efforts were funded with revenues from the State and grants obtained from various sources. The establishment of the F&W program unfortunately coincided with reduced State appropriations to the FRL as a result of the passing of Measure 5 and decreased timber harvest on federal lands. Thus, in the first few years of the F&W Program, the revenues from the increased Harvest Tax rate were critical in ensuring the timely completion of those existing fish and wildlife studies and maintaining an adequate core of faculty expertise.

In recent years, all activities funded through the F&W Program are new efforts that address timely issues identified collaboratively by the Technical Advisory Committee, College program leaders, and the faculty. Since 2002, new projects have been selected with a priority towards those that contribute to the scientific information base that supports the Oregon Forest Practices Act.

Many of the F&W Program’s activities have been conducted with additional funds from several sources, making their “value” far greater than the funds from the Harvest Tax. This is not duplication of funding, but illustrates how Harvest Tax funds are leveraging other resources, making “the dollars go farther.” Without the FRL funds AND the other funds, many of these projects would not be possible. Other FRL programs continue to contribute to or complement the goals of the F&W Program. Funded from a variety of sources, these activities are not included in documents describing this F&W Program because they are not explicitly part of the effort funded by the increase in Harvest Tax rate.

The budget for FY2006 is $370,000, based on a projected harvest of 3.70 billion board feet. One research project was completed in FY2005 and one service activity slated for funding was canceled, providing resources for reallocation to new activities. Based on the advice of the F&W Program’s Technical Advisory Committee, these resources are sufficient to initiate one new project and continue seven research projects.

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

Hal Salwasser, Dean and Director
College of Forestry and Forest Research Laboratory
July 1, 2005
Historically, fish, wildlife and timber have been managed largely independently. With increasing demands for more of all of these resources from a common land base, it has become essential to find ways in which their individual productivities can be optimized in aggregate. Current forest resource management, policy, and regulation attempt to do this, but they are hampered by serious gaps in knowledge. In some cases these are very specific gaps, requiring testing of a specific strategy. In other cases it is a larger and more fundamental gap, requiring the development and testing of new concepts. This enhanced program of research, service and technology transfer was developed to fill at least a portion of these gaps. The goal is to provide the information needed by forest managers and policy makers in the establishment and evaluation of forest policy, and the active management of Oregon forests, with a specific focus on the science needed to support the Oregon Forest Practices Act.

The purpose of this document is to describe the Fiscal Year 2006 activities of the FRL that comprise the program funded by the 1993 legislative increase in the Oregon Forest Products Harvest Tax rate. This document is organized by new and continuing projects and activities, which can be sorted into three areas: a) Research, b) Service and c) Technology Transfer. Oregon Forest Products Harvest Tax revenues fund projects and activities wholly or in part. A description of each active project follows this introduction.

Research: One new research project was initiated in FY2006:

1) Analysis of Cumulative Impacts on Biotic and Abiotic Responses in Stream Networks Due to Contemporary Forest Practices

Seven continuing research projects are funded by this program in FY2006, including:

1) The Effect of Road Characteristics and Road/Stream Connectivity on Delivery of Sediment to Streams in the Oak Creek Watershed.

2) The Influence of Riparian Vegetation and Stream Condition on Water Quality After timber Harvest on Non-Fish-Bearing Headwater Streams.

3) Response of Macroinvertebrates to Harvest in Hinkle Creek Headwaters.

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

5) Managed Forests and Their Role in Maintaining Water Quality in a Multi-land Use River Basin.

6) Habitat Conservation for Stream Amphibians in a Managed Forest Landscape.

7) The Hinkle Creek Paired Watershed study: The Effects of Timber Harvesting Adjacent to Non-Fish-Bearing Streams on Cumulative Water Quality Effects in Fish Bearing Streams.

Service: The service area includes activities that are not research, but which support current forest management and policy development activities. No active projects are underway this year.
Technology Transfer: Technology transfer is a function that is an integral part of the research process. No active projects are underway this year.
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# Budget for FY 2006

**July 1, 2005 - June 30, 2006**

## New Projects and Activities

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<th>Project Description</th>
<th>FY2006</th>
<th>FY2007</th>
<th>FY2008</th>
<th>FY2009</th>
<th>FY2010</th>
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<tr>
<td>Analysis of Cumulative Impacts on Biotic and Abiotic Responses in Stream Networks Due to Contemporary Forest Practices (2006-2009)</td>
<td>14,973</td>
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**Sub Total of New Projects** $14,973

## Continuing Projects and Activities

<table>
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<th>Project Description</th>
<th>FY2006</th>
<th>FY2007</th>
<th>FY2008</th>
<th>FY2009</th>
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<tr>
<td>The Effect of Road Characteristics and Road/Stream Connectivity on Delivery of Sediment to Streams in the Oak Creek Watershed (2005-2007)</td>
<td>40,000</td>
<td>40,000</td>
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<td>The Influence of Riparian Vegetation and Stream Condition on Water Quality After Timber Harvest on Non-Fish-Bearing Headwater Streams (2005-2007)</td>
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<td>Response of Macroinvertebrates to Harvest in Hinkle Creek Headwaters (2005-2007)</td>
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<td>Contributions of Riparian Vegetation to Terrestrial and Aquatic Food Chains: Contrasting Alder and Douglas-fir Riparian Forests (2004-2006)</td>
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<td>Managed Forests and Their Role in Maintaining Water Quality in a Multi-land Use River Basin (2004-2006)</td>
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<td>Habitat Conservation for Stream Amphibians in a Managed Forest Landscape (2004-2008)</td>
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<td>The Hinkle Creek Paired Watershed study: The Effects of Timber Harvesting Adjacent to Non-Fish-Bearing Streams on Cumulative Water Quality Effects in Fish Bearing Streams (2004-2006)</td>
<td>50,000</td>
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**Sub Total of Continuing Projects** $266,315 $179,991 $36,000 $30,000

**Totals** $281,288

1 Total FY2006 budget is $370,000, of which $277,175 is available for allocation to projects after 33% overhead is expended. The total includes $4,113 of unallocated funds from FY2005.
New Projects

Following guidance by the Technical Advisory Committee and final approval by the FRL Director, one new activity was initiated in FY2006. New projects are intended to meet high priority needs identified during the annual advisory committee meeting.

New Research Project 1

Title: Analysis of Cumulative Impacts on Biotic and Abiotic Responses in Stream Networks Due to Contemporary Forest Practices (2006-2009)

Principal Investigators: Lisa M. Ganio, Robert Gresswell, Judith Li, and Arne Skaugset

Relevance to program mission: The impacts of contemporary intensive forest management activities on stream ecosystems are being studied at the “Hinkle Creek Paired Watershed Study.” As a part of this study, the cumulative effects of contemporary forest management activities on the physical, biological, chemical characteristics of the terrestrial, riparian and aquatic ecosystems is being studied at the scale of a complete 5,000 acre watershed. A study plan authored by the principle investigators of the Hinkle Creek Paired Watershed Study identified the complex interactions among these systems and the need to integrate multiple response variables over multiple spatial and temporal scales. The analysis of the interactions between the response and explanatory variables over multiple spatial and temporal scales is further complicated by their association along a stream network. The data obtained from a stream network includes characteristics that increase the complexity of any resultant analysis.

1. Spatial autocorrelation in a stream network is a concern when data are collected in close physical proximity. Spatial analysis methods for stream networks need to account for distance between points along the network, not as-the-crow-flies distance. But such analysis methods for networks are not used routinely or available in existing software.

2. Connectivity or neighbor relationships (in spatial analysis) between points must account for flow patterns through the network. In some cases the connectivity relationships are clear (e.g. sediment flows downstream) and other cases may be more difficult to elucidate (e.g. how far up and downstream will/do amphibians move?).

An important objective in the Hinkle Creek Study is the integration of responses from multiple spatial and temporal scales to examine the downstream cumulative impacts of management on the subject area responses. Comments by reviewers of the original study plan pointed out the need for a better description of the data analysis that would consider cumulative impacts and better describe the integration that would occur between the original disciplinary projects. Such an analysis and integration must appropriately account for flow through the system and for spatial autocorrelation at the relevant scale. This project would develop the appropriate analysis methods for data from stream networks and describe how data from the individual disciplinary research projects would be integrated. These methods would be applicable to any ecological network and specifically apply to the multiple response variables in paired-watershed studies designed to address cumulative impacts of forest management on biotic and abiotic components of stream systems.
Objectives
1. Summarize existing statistical models used in natural resources and quantitative ecology to account for flow and autocorrelation for data from stream networks.
2. Evaluate the adequacy of these methods for the analysis of cumulative effects in paired-watershed studies.
3. Develop data analysis strategies to account for spatial autocorrelation and directional flows in data from paired watershed studies.

Approach
1. A summary of statistical modeling, methodology and strategies used in ecological network settings and described in the peer-reviewed literatures of hydrology, wildlife management, fisheries, stream ecology, statistics and quantitative ecology will be produced. Methodologies and models that incorporate spatial and temporal autocorrelation, cumulative effects and directional flow will be targeted. We will also specifically search for any methods used in ecological network settings.
2. Several methods best suited to the research hypotheses of the Hinkle Creek Study will be identified and applied to data from this study. Strengths and weakness of these approaches will be identified and recommendations for future stream and watershed studies will be produced.
3. A statistical analysis strategy (e.g., models, methods) for integrating autocorrelation and flow information into data analysis will be developed for ecological questions from branched stream settings. We anticipate integrating methods from multiple fields and potentially developing new methods.

Timeline: PhD student would begin in Fall 05. Objective 1 would be accomplished by Fall 06; objective 2 would begin during Summer 06 and continue through at least Fall 07; objective 3 would begin Summer 07. (FY2006-2009)

Budget: We are requesting 4 years of funding to support a PhD student.

Year 1 (FY 06): $25,000
Year 2 (FY 07): $30,000
Year 3 (FY 08): $30,000
Year 4 (FY 09): $30,000
Continuing Projects

These projects continue from last year’s program. They contribute directly to the goals of this research program and are funded at least partially by Oregon Forest Products Harvest Tax and reflect the FRL’s commitment to learning more about how to enhance the compatibility between timber, fish and wildlife values in managed forests. These studies include the following:

Study 2: The Effect of Road Characteristics and Road/Stream Connectivity on Delivery of Sediment to Streams in the Oak Creek Watershed (2005-2008)

Principal Investigator: Arne E. Skaugset, Associate Professor, Dept. of Forest Engineering

Collaborating Scientist: George G. Ice, NCASI

Relevance 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 activities, has increasingly focused on fisheries and aquatic habitat. The environmental effects of forest roads and road systems have come under increased scrutiny in recent years. Forest roads are directly connected to streams at stream crossing culverts. This connectivity is hypothesized to have the potential to cause an overall change in watershed hydrology including increased peak flows and result in chronic fine sediment delivery to streams. There is a general belief that one of the persistent environmental impacts of forest management activities is an overall change in watershed hydrology due to the presence of forest roads. Roads can cause changes in flow pathways and reroute subsurface flow in hillslopes and these changes are generally believed to have a deleterious effect on fisheries by changing watershed hydrology and increasing sediment delivery to streams. For this project the amount of fine sediment that is yielded by different road segments in Oak Creek will be measured and the relative role that the roads play with regard to total watershed sediment yield in Oak Creek can be observed.

Objectives:

• To determine the influence of road and site characteristics, including the hydrology of the individual road segment, on the amount of fine sediment generated by the road.
• To determine the amount and timing of sediment from connected road segments relative to the sediment load carried in the live stream where the road segment(s) are connected.
• Use sediment yield, road characteristic, and site characteristic data to verify or validate road sediment models such as SEDMODL, WEPP.

Overview of Approach/Methods: The study site will be the headwaters of the Oak Creek Watershed within the McDonald/Dunn Research Forest. This watershed is a place where intensive data collection continues to investigate the hydrology of the roads and the roaded watershed. Discharge and suspended sediment are measured in Oak Creek at the school forest boundary. There are 98 drainage structures on the roads in Oak Creek and a device to measure water level is installed on each drainage structure. Twenty-two of these structures are stream crossing culverts and flumes are installed in the road ditches that drain into the streams on 16 of these streams. Precipitation intensity is measured at four tipping buckets throughout the watershed and air temperature, relative humidity, wind speed, and solar radiation are measured at a micrometeorological tower. Thus, a detailed and spatially distributed record of the hydrology of the road system and the watershed exists.
Sediment will be measured at 10 to 15 of the culverts, depending on resources. The sediment will be measured using turbidimeters connected to data loggers and ISCO water samplers. A continuous trace of turbidity will be collected at a given culvert. Periodic water samples will be collected using the ISCO and the suspended sediment concentration of the water samples will be determined. A suspended sediment/turbidity relationship will be developed and applied to the continuous record of turbidity that will yield a continuous trace of suspended sediment. This equipment will be installed at the outlet of cross drain culverts to develop information regarding the characteristics of individual road segments and sediment yield. The equipment will be installed above and below roads at stream crossing culverts to determine the sediment yield of the roads and their relative contribution to the sediment load of the stream. Due to the extensive data that has been collected on the hydrology of the roads, it will be possible to install the equipment that will collect sediment data at locations on the road system that will be optimum for sediment data collection.

**Timeline:** A three-year timeline is proposed.

- **Project Initiated**  FY 2005
- **Project Terminated**  FY 2008

**Budget:**

The budget will support a research assistant for 0.5 FTE of one year and a master’s student for approximately 2 years.

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<th>FY 05:</th>
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<td>$ 40,000</td>
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Study 3: The Influence of Riparian Vegetation and Stream Condition on Water Quality After Timber Harvest on Non-Fish-Bearing Headwater Streams (2005-2008)

Principal Investigators: Arne Skaugset, Associate Professor, Dept. of Forest Engineering  
Stephen H. Schoenholtz, Associate Professor, Dept. of Forest Engineering, Kermit Cromack, Professor, Dept. of Forest Science

Relevance to Program Mission: The regulation of forest management activities around non-fish-bearing streams is a source of continuing and growing concern. The importance of fish-bearing streams and the assignment of appropriate protection measures, including riparian buffer strips, are well known and accepted. There are classification systems in place for streams and appropriate protection measures to prescribe in all forest practice rules. While the details of some of the protection measures, such as the width of riparian buffer strips, may be debated, there is general agreement that the scientific principles for identifying and classifying streams and assigning protection measures is sound. The same statement can not be made for non-fish-bearing streams.

The primary concern regarding non-fish-bearing streams is downstream water quality in fish-bearing streams. For timber harvesting adjacent to non-fish-bearing streams to affect fisheries and aquatic habitat downstream in fish-bearing streams, there must be a vector to enable such effects to occur. The most likely vector is, of course, the water in the streams. Harvesting in the non-fish-bearing streams can cause changes in water quality of these streams that can be transported downstream to the fish-bearing streams. It is hypothesized that this effect is magnified when multiple non-fish-bearing-streams that drain to one fish-bearing stream are harvested simultaneously. Water quality parameters that are most likely to be affected and that of the most contemporary concern are temperature, sediment, and to a lesser degree downstream transport of terrestrially derived organic debris.

The Hinkle Creek Paired Watershed Study is set up to investigate the cumulative effects of downstream aquatic habitat of timber harvest in multiple non-fish-bearing streams. The current experimental design at Hinkle Creek is set up to investigate changes in water quality due to timber harvest adjacent to non-fish-bearing streams. However, the current design is set up as a black box. There is no plan, at present, to investigate the processes that will be affected and result in changes in water quality. This project allows us to concentrate on the key parameters that can be affected by timber harvesting and can have a subsequent significant effect on water quality. The key processes are shade producing vegetation and the condition of the stream bed and banks and the key water quality parameters are stream temperature and sediment yield.

Objectives:

1. Establish baseline characterization of stream condition and riparian composition in small, non-fish-bearing streams prior to timber harvesting treatments.
2. Determine effect of riparian buffers on condition and composition of stream channels and riparian areas after timber harvesting in small, non-fish-bearing streams.
3. Correlate changes due to harvesting in the condition and composition of stream channels and riparian areas with documented changes in water quality in small, non-fish-bearing streams.
Overview of Approach/Methods: This project will be part of the Hinkle Creek Paired Watershed Study. In that study, the effect of harvesting using contemporary forest practices on water quality in small, non-fish-bearing streams will be investigated. Six small, perennial, non-fish-bearing streams are instrumented to collect discharge, sediment, and temperature data. After a two-year calibration period, in four of the watersheds timber harvesting will occur adjacent to significant portions of the streams while the remaining two small watersheds will remain untreated and serve as controls. After timber harvest has occurred, the effect of the harvest on water quality, specifically stream temperature and sediment yield will be quantified.

Before timber harvest occurs, stream condition and the composition of the riparian vegetation for the six, non-fish-bearing streams will be determined. Stream condition will be quantified using a variant of an aquatic habitat inventory method that will pay special attention to the loading and size distribution of large pieces of wood and other organics. The composition of the riparian vegetation will be determined using riparian plots as well as line transects in the riparian areas. After harvest has occurred, these same methods for stream condition and the composition of riparian vegetation will be repeated for both the harvested and control watersheds. The changes in stream condition and riparian composition will be quantified.

The changes, or perhaps lack of change, that are observed in stream condition and riparian vegetation composition that are associated with the timber harvest can be used as explanatory variables for the observed changes in water quality.

Timeline:

This is intended to be a three-year study. It will be initiated in FY 2005 and will be terminated in FY 2007. Timber harvest will occur in Hinkle Creek during the 2005 calendar year or at the beginning of FY 2006. This timing will allow one plus summers of pre harvest data collection and one summer of post harvest data collection.

    Project initiated: 2005
    Project Terminated  2007

Budget:

This project will support a graduate student, either a master’s or PhD student for the duration of the project. Because the work will take place in Hinkle Creek by Roseburg, logistical support will be required.

    FY 05: $30,000    FY 06: $30,000    FY 07: $30,000
Study 4: Response of Macroinvertebrates to Harvest in Hinkle Creek Headwaters (2005-2008)

Investigators: Judith Li, Associate Professor, Department of Fisheries & Wildlife, OSU
              John Hayes, Professor, Department of Forest Science, OSU

Relevance to Program Mission: Invertebrates are good indicators of fine-scale spatial and temporal responses to disturbance; moreover, assemblage structure and changes in biomass can also assess cumulative effects. We suggest that they are good integrators of change in altered landscapes such as those planned at Hinkle Creek. This study will be integral to a multi-disciplinary, multi-year assessment of industrial forestry practices in headwaters of Hinkle Creek initiated by the Watersheds Research Cooperative (WRC), in which private industry, particularly Roseburg Forest Products, state and federal agencies, and the two OSU departments represented by Dr Li and Dr. Hayes are collaborating. Our study will be coordinated with other Hinkle Creek studies on hydrology (A. Skaugset), soils (K. Cromack), amphibian distribution (J. Hayes & M. Adams) and fish distribution (R. Gresswell). Stream invertebrates will be viewed not only as habitat indicators, but also important elements in watershed processes, particularly food web dynamics.

Objectives: The objectives of the study will be to examine:

- annual fluctuation in assemblage composition and biomass prior to harvest,
- effects of harvest on macroinvertebrates in headwaters with and without fish,
- localized effects adjacent to harvest and cumulative downstream effects and
- effects of harvest fish and amphibian diet.

Basic overview of approach/methods: The paired watershed approach, with predictable harvest schedules, greatly enhances our ability to assess immediate and long-term effects. Invertebrate distributions are inherently patchy, requiring multiple samples and repeated sampling events to establish sub-watershed characteristics. Without previous funding, we have already collected autumn invertebrate samples, in recognition of the momentary opportunity for determining pre-harvest conditions (n=14, 6 samples/site). These were paired sites, above and below occurrence of fish in headwaters only. In this proposal we include enumeration of these samples, collection of an expanded set of samples, and the addition sampling for diet. Study design contrasting south and north forks of Hinkle Creek will compare effects of harvest on headwaters in reaches within and downstream of harvest activities. Invertebrate samples will be composited by reach to speed enumeration and analysis. Biomass will be determined by measuring for length and converting to biomass by regression. Multivariate analysis will be used to examine patterns of assemblage structure, biomass, and life history characteristics.

Timeline:
Spring 2004: Expand sampling to 24 samples (8 on mainstems); sample fish diet Summer/Fall 2004: Enumerate fall samples 2002, 2003 (n=14/year x 6/site); enumerate fish diet 2004; resample spring sites;

Spring/Summer 2005: last sampling prior to harvest: repeat 24 samples; sample fish and amphibian diet; enumerate 2004 samples and spring 2005 diet;

Fall 2005: first sample following harvest; fish & amphibian diet; enumerate Spring 2005 samples
Spring /Summer 2006: resample post harvest sites; enumerate Fall 2005, Spring 2006 samples
Fall/Winter 2006: Complete analysis

Budget:
Because of other constraints on time for Dr. Li, we propose this project be a primary responsibility of her research assistant, Bill Gerth who has 12 years experience in her aquatic ecology lab. He is expert in aquatic invertebrate identification, particularly for Oregon, and experienced with sampling in varied stream ecosystems. The budget includes one field helper and one assistant in the laboratory for initial sorting and weighing activities. We will need an additional Surber sampler for this study; all other supplies will be expended within annual field and laboratory cycles.

FY05: $32,380    FY06: $32,527    FY07: $34,191
Study 5: Contributions of Riparian Vegetation to Terrestrial and Aquatic Food Chains

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.

Study 6: Managed Forests and Their Role in Maintaining Water Quality in a Multi-land Use River Basin (2004-2006)

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


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-land use 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.
Study 7: Habitat Conservation for Stream Amphibians in a Managed Forest Landscape (2004-2008)

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 watersheds 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 choose 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.
Study 8: 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 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 to 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.

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<tr>
<th>Project Initiated</th>
<th>FY 2004</th>
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<td>Project Terminated</td>
<td>FY 2007</td>
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**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
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