Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Strategies For Riparian Recovery: Plant Succession & Salmon

Bonneville project number, if an ongoing project 9141

Business name of agency, institution or organization requesting funding
Oregon State University

Business acronym (if appropriate)

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name
Snowy Butte Helicopters Inc.	1222 Modor Rd.	White City, OR 97503	Karen Gunther

NPPC Program Measure Number(s) which this project addresses.

NMFS Biological Opinion Number(s) which this project addresses.

Other planning document references.

We are presently working with the Umatilla National Forest in funded projects related to mining restoration, flood effects, stream temperature patterns, and fish distribution.

OSU Extension program is incorporated into this study through the participation of Dr. Reed. Through his office we are cooperating with the Umatilla Basin Watershed Council, Hermiston Irrigation District and private landowners.
We have contacted the Confederated Tribes of the Umatilla.

Subbasin.
Blue Mountains, Umatilla

Short description.

Determines the role of riparian plant diversity, structure and density on fish diet and habitat. Examines temporal and spatial dynamics of riparian inputs, particularly cottonwood and willow, and their use by aquatic biota (invertebrates, salmonids).

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction	+	Watershed
+	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production		Population dynamics
	Oceans/estuaries	+	Research	+	Ecosystems
	Climate	+	Monitoring/eval.		Flow/survival
	Other	X	Resource mgmt		Fish disease
			Planning/admin.		Supplementation
			Enforcement	X	Wildlife habitat enhancement/restoration
			Acquisitions		

Other keywords.
Riparian, Invertebrates, Ecological interactions; Detritial dynamics

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Examine physical features of streams associated with riparian stands of different stages	a	Obtain and analyze aerial photographs of the Umatilla Basin from different years
		b	Reconstruct changes in structure, density and extent of riparian zone through time
		c	Reconstruct patterns in stream channel morphology through time
		d	Ground truth aerial photographs
		e	Collect FLIR imagery
2	Compare terrestrial input of riparian stands differing in plant diversity	a	Examine nutrient quality of native & exotic vegetation
		b	Quantify timing and biomass of litter infall to streams
2	Compare terrestrial invertebrate input from riparian stands of differing plant diversity: phenology and abundance	c	Identify & quantify terrestrial insect assemblages from different plant assemblages (litter fall and drift)
3	Analyze aquatic invertebrate response to riparian diversity	a	Quantify aquatic invertebrate abundance and diversity associated with diverse riparian plant species (leaf packs and drift)
4	Examine differences in native fish densities, diet, and growth rate associated with riparian stands differing in plant diversity	a	Census fish communities at reaches flowing through riparian communities of differing structure, density and extent
		b	Examine pumped fish stomach samples of drift-feeding yoy salmonids
		c	Determine growth rates of yoy salmonids through photogrammetric methods

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	10/1998	9/1999	30.00%
2	3/1999	9/1999	20.00%
3	3/1999	9/1999	25.00%
4	3/1999	9/1999	25.00%
			TOTAL 100.00%

Schedule constraints.
No major constraints;

Completion date.
2002

Section 5. Budget

FY99 budget by line item

Item	**Note**	**FY99**
Personnel	Includes 6 Principal Investigators, 5 graduate students, and research assistants	$148,449
Fringe benefits	Varies depending on position	$32,276
Supplies, materials, non-expendable property	Field equipment, office supplies, laboratory costs etc.	$18,018
Operations & maintenance		
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	Microscope; flow meter, fluorometer	$16,000
PIT tags	# of tags:	
Travel	Fieldwork (Corvallis - E. Oregon); presentations at meetings	$27,500
Indirect costs	43% of costs	$108,035
Subcontracts	FLIR imagery by helicopter	$25,000
Other	Graduate Tuition	$26,400
TOTAL		$401,678

Outyear costs

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
Total budget	$378,000	$396,900		
O&M as % of total	0.00%	0.00%		

Section 6. Abstract

The precarious standing of many salmonid stocks in the Pacific Northwest demands extraordinary measures to improve the odds for their survival. An important component for habitat restoration is undoubtedly riparian vegetation because it generates plant litter, insect litter and woody structure, as well as providing bank structure and shade. Recent initiatives propose to restore riparian corridors through extensive planting; but we know little of riparian vegetation succession, of the dynamics controlling availability of riparian inputs to streams, or how these inputs are connected to the distribution and life cycles of the biota in Oregon watersheds. The proposed study will determine how hardwood riparian recovery proceeds and the time required for recovery of stream functions, and will build a framework for designing riparian restoration programs in northeast Oregon. We will reconstruct riparian community succession by analyzing time series of aerial photographs of riparian zones in different areas, and also use these images to establish study sites of varying composition and age. Differences in timing and composition of riparian input will be compared among stands ranging from relatively uniform to highly diverse ones. We will survey both in-stream and riparian zone characteristics of each site, where riparian litter, terrestrial insects, aquatic insects, and fish will be quantified. To study the potential of riparian inputs to fish diet, drift samples and fish stomach contents will be separated into components derived from terrestrial and aquatic sources. Fish growth will be compared between sites to estimate the relative value of these sources.

Section 7. Project description

a. Technical and/or scientific background.

The decline of Pacific salmonids have coincided with the increase in human activities, which include disruptions of the riparian zones (Nehlsen et al. 1991). In the mid-nineteenth century, when pioneers arrived in the fertile valleys of the Pacific Northwest, riparian forests of deciduous hardwoods lined most river floodplains (Sedell and Frogatt 1984). Since that time, channelization (Swift 1984; Decamps 1993), grazing (Kauffman 1988), agricultural activities (McGill 1979), water withdrawal, and flood control (Decamps et al. 1988) have dramatically reduced these riparian forests and constrained interactions between streams and their adjacent riparian forests. Riparian zones are important ecotones between terrestrial and aquatic systems (Naiman and Decamps 1997). Allochthonous materials (organic matter from riparian vegetation) transfer energy between these two systems. Riparian zones also serve to filter nutrients (Schlosser and Karr 1981), stabilize banks (Gregory et al. 1991) and provide shade for streams (Li et al. 1994). Although the importance of riparian vegetation to the function of streams has been recognized for many years (Hynes 1970), specific processes linking the distribution of aquatic organisms with riparian vegetation inputs generally have not been well understood or predictable (Behmer and Hawkins 1986, Sweeney 1993, Johnson and Covich 1997). To improve our understanding of these interactions, we suggest that a multidisciplinary approach is required; both aquatic and terrestrial expertise is necessary for identifying components and processes at these ecotones. Observations at multiple spatial and temporal scales are necessary to understand the dynamics controlling availability of allochthonous materials, and how these inputs are connected to the distribution and life cycles of the biota.

There is no question that we need to restore watersheds so they can be fully functioning (Brouha and Chappell 1997, Dombeck et al. 1997). However, problems arise when we consider how we should proceed. Kauffman et al. (1997) stress the importance of passive restoration by removing the source of human disturbance and allowing natural processes to operate. Roper et al. (1997) believe that watersheds have become so degraded that some degree of human intervention is necessary. Human intervention to improve watersheds and supplement fish numbers has a checkered history. On one hand successes have been reported (House and Boehne 1985; Cuenco 1994); on the other hand, failures have been documented (Frissell and Nawa 1992; Meffe 1992). Clearly the middle ground is that restoration will require understanding and integrating natural processes rather than relying on an entirely technocratic solution (Sedell and Beschta 1991; Stanford et al. 1996, Ebersole et al. 1997).

We are now moving away from site-specific, engineered structures towards recovery of riparian vegetation for restoring stream channel complexity. The discussion of human intervention does not end here as some advocate speeding up vegetative recovery by planting riparian trees (Figure 1). For instance, riparian plantations along Coast Range streams has been proposed and planting of willows, although mostly unsuccessful, has occurred. Our fear is that beyond the good intentions of tree planters, we will fall into cook book procedures instead of trying to mimic natural succession. In Europe, for instance, plantations of exotic monocultures have replaced the natural diversity of riparian vegetation along stream banks of various watersheds (Cortes et al. 1994). This has changed the trophic structure of affected streams and influenced the input of terrestrial invertebrates that form the bulk of drifting prey for surface feeding fishes in headwater streams. In the Pacific Northwest it is necessary to develop a strategy to (1) determine when human intervention is required and (2) determine when and where vegetative recovery can lead to recovery of stream function.

Our working hypotheses are:

1. Recovery of stream function and processes will follow and lag behind riparian succession.
2. Channel structure complexity will require additional time beyond the reestablishment of native plants.

By determining how hardwood riparian recovery proceeds and the time required for recovery of stream functions, we expect to build a framework for designing riparian restoration programs in northeast Oregon. These scenarios should help determine how much and what types of biotechnology can be employed to improve recovery time and project success.

Then the decision rule is easy:

Intervene when the time to recovery of riparian function (successional time) exceeds the estimated time to extinction for stocks.

We seek to set biological rules required for triage decisions before investing money towards watershed recovery.

Setting the goals of restoration

Land managers need an understanding of riparian vegetation succession under various types of disturbances and benchmarks for recovery of stream function. We also need estimates of the length of time these processes take. We have begun an autecological model of how this might proceed (Figure 1), but we need to understand these processes/mechanisms more explicitly on a community basis. We propose to do this through the complementary tasks of analyzing time series of aerial photographs and fieldwork on specific sites.

We also need to understand the role of vegetative diversity as it affects stream functions upon which native fishes depend. We suspect that a major difference between monocultural stands, which might result as a product of "stream restoration", and diverse native stands is the phenology of vegetative input into the streams. Some monocultures may have only one leaf input and coarse woody debris peak during the year, whereas diverse communities will have broader intervals of input depending upon the species mix (Figure 2). This will have significant ramifications with respect to energy transfer to the stream and the composition and production of stream invertebrates. Cortes et al. (1994) found major differences in the community structure of terrestrial invertebrates in the native alders of Portugal in contrast with those inhabiting exotic eucalyps. We suspect that monocultural stands may support different terrestrial and aquatic invertebrate faunas compared to diverse stands, and that this will affect food available to drift-feeding salmonids.

Though generalist predators, salmonid YOY are primarily insect feeders. The diet of immature chinook salmon has been shown to be 95% insects and immature coho salmon consume about 99% insects (Johnson and Ringler, 1980). Steelhead diets are largely insect as well (Johnson and Ringler, 1980). Because herbivorous species produce the largest biomass and number of individuals in most ecosystems, they may provide an important component of YOY diet. Most herbivorous insect species have very explicit host plant species requirements. If host species are not present, the herbivore species which depend on them will be absent from the ecosystem as well. Young of the year diet is well known to be a combination of terrestrial and aquatic invertebrates; but we know little of the factors contributing to the relative importance of these two components. Riparian vegetation may play an important role in both availability and prey quality.

We are interested in other functions associated with riparian stands at different successional stages, chiefly those associated with salmonid habitat complexity and channel structure. Features such as channel sinuosity, habitat type distribution, amount of large woody debris and the presence of undercut banks may be affected by the composition of riparian vegetation.

By examining the temporal, compositional and spatial influences of hardwood riparian zones on stream processes and native fishes, this study will establish the information needed for restoration strategies of riparian zones and native fish habitats.

b. Proposal objectives.

Our research will determine the role of riparian plant diversity, structure and density, on native fish food sources and habitats.

Specifically we want to examine:

1. the physical features of streams associated with riparian stands at different successional stages, such as channel structure, habitat type distribution, particularly the frequency of large pools, instream cover (undercut banks, woody debris, vegetation), and stream temperature.
2. differences in allochthonous and invertebrate input from riparian stands of different plant diversity with respect to the phenology of allochthonous CPOM, the amounts of allochthonous CPOM, the phenology and amount of terrestrial invertebrate input, and biomass of drift.
3. stream invertebrate response to differences in riparian diversity: community diversity, biomass and phenology.
4. differences in densities of native fishes that result from objectives 1 and 2 and supportive details concerning diet and growth rate of yoy salmonids.

Hypotheses

Historical analysis of riparian sucession:

Hypothesis: The sequence of riparian succession follows the autecological model shown in Fig. 1.

Measurements of litter/allochthonous inputs of plant material:

Hypothesis: The input of litter and allochthonous material is greater and occurs over a larger time span in riparian zones of higher vegetative diversity.

Invertebrate communities in different riparian species (trees, shrubs, grasses, sedges):

Hypotheses: (1) Standing crops of terrestrial invertebrates and species richness are higher in riparian zones of higher diversity; (2) Species composition and biomass of herbivorous invertebrates associated with native plants provide a more sustainable food supply for salmonid young of year (YOY) than exotic plant species.

Influence of allochthonous inputs of plant material to stream invertebrates:

Hypotheses: Food resources for aquatic invertebrates are of greater quantity, more preferred and of higher quality in riparian zones with high native plant diversity; therefore, (1) Standing crops of aquatic invertebrates are higher in areas of greater riparian diversity; (2) Invertebrate species richness is higher in areas of greater riparian diversity; (3) Native plant material supports more invertebrates than exotic species.

Stream drift: invertebrates, allochthonous and autochthonous contributions

Hypotheses: (1) Higher mass of drift will be associated with areas of greater riparian diversity, with allochthonous drift exceeding autochthonous drift in salmon bearing streams; (2) Quality and quantities of drift will be less variable among seasons in reaches with high native plant riparian diversity.

Measurements of stream morphology and habitat complexity:

Hypothesis: Riparian zones of higher diversity will have fish habitats of higher complexity and have lower rates of heat gain than less diverse systems.

Measurements of Fish Habitat Quality

Hypotheses: (1) On average, YOY salmonids will have higher stomach fullness and faster growth rates in riparian zones with higher species diversity than in those with less; (2) Allochthonous prey will constitute a higher fraction of the diet than autochthonous stream invertebrates; (3) Fish densities will be higher in riparian zones of greater plant and/or invertebrate diversity.

c. Rationale and significance to Regional Programs.

Approximately 80% of the Columbia River drainage lies within the high desert east of the Cascades. Historical records and photographs suggest that many of the river floodplains in this vast landscape were lined with cottonwood riparian galleries, but few remain intact. Significant stands occur in the Umatilla River Basin where this study will be focused.

These eastside river basins once provided extensive habitat for anadromous and resident fishes. The precarious status of 76 stocks of native salmonid fishes was recognized almost a decade ago (Nehlsen et al 1991), and little has changed. All Columbia River steelhead stocks currently are under review, and bull trout are proposed for threatened status. The trajectory of fish declines continue despite millions of dollars invested by BPA and other agencies such as USDA Forest Service and BLM. Though numerous factors contribute to these declines, habitat and food resources and habitat availability are key factors. Even as Oregon initiates new strategies for stream restoration past lessons compel us to build a strong understanding of the ecosystem processes we wish to mimic.

The Conservation Reserve Enhancement Program is a federally funded offshoot of a USDA program to prevent soil erosion. It was reported through the Oregonian (January 19, 1998) that land owners in participating states would set aside “environmentally sensitive land for as long as 30 years and replant them with trees and grasses”. Plans to rehabilitate urban streams in the greater metropolitan Portland area are also underway and efforts to re-establish riparian corridors are under discussion. As the Pacific Northwest region moves into these new modes for stream restoration, fundamental understanding of critical components of processes in riparian ecosystems is essential.

d. Project history

new start

e. Methods.

Site selection for field studies:

All our study sites will be selected from the Blue Mountain Ecoregion. We will account for land use, elevation, irrigation, stream gradient, aspect, stream size and extent, structure and vegetative diversity of the riparian zone in selecting the study sites. We will use historical analysis of aerial photos to select sites for which we can reconstruct ecological histories. We will account for exotic species in the analysis, although it may be difficult to block the sampling scheme for this factor alone. We will examine habitats with similar potentials but which differ with respect to riparian diversity. A multiple regression design may be used to account for the extent and density of the riparian vegetation at each site versus community responses. We will sample the lowest reach of stream contiguous with the selected structure of riparian vegetation. A focal site is the area most affected by cumulative upstream processes (Li et al. 1994) whose length is 40 channel widths. This length of reach has been determined to be of a sufficient length to capture the representative habitats at the scale of stream reaches and therefore to assess the species composition of streams (Stan Gregory, personal communication; Lyons 1992). At each site, we will sample aquatic fauna, invertebrate and allochthonous drift, and evaluate habitat conditions.

Historical analysis of riparian sucession:

We propose to reconstruct riparian community succession by analyzing time series of aerial photographs of riparian zones in different areas. We will be able to determine vegetative structure, vegetative density, community type, tree composition, and extent of the riparian zone. We can determine stand age through back calculations from images within the time series. We will also visit sites and obtain ages of distinctive trees to verify the back calculations.

The current vegetation composition of the entire floodplain will be mapped utilizing low-level aerial photos and extensive ground-truthing. Historical interpretations of composition will be derived from these results in comparison with historical photos. In the experimental reaches, each vegetation stand will be identified and classified based upon the dominant species in each vegetation layer (i.e., tree, shrub, and herb layers). Within each of the dominant plant community types, changes in plant composition will be quantified through permanent transects where species frequency and size will be measured. Ecosystem mass will be quantified as the sum of each stand area multiplied by the average mass of its community type. All vegetation measurements will follow that of Case (1995) for mass and Kauffman et al. (1985) for composition and diversity. This data will be transferred into GIS data layers using ArcInfo™ software. Sites will be geo-referenced by groundtruthing and employing GPS.

Measurements of litter/allochthonous inputs of plant material:

In each of the sampled reaches allochthonous inputs will be quantified via litterfall traps and annual surveys of large wood debris. Litterfall will be quantified utilizing 10- 25 X 75-cm traps suspended over the stream surface at each reach. In addition, a paired perpendicular trap will be placed on the stream's edge to capture the lateral inputs. We have found this to be a successful design to quantify litter inputs in NE Oregon streams. Litter will be collected every 2-4 weeks with more frequent collections during the spring and autumn months. Litter will be separated into leaves, needles, wood materials (twigs, cones, bark), lichens/moss, reproductive parts (flowers, catkins, and seeds). Collected allochthonous materials will be transported to the lab and analyzed for C and N utilizing a Carlo-Erba NCS analyzer. From these data, biomass and inputs of C and N can be calculated on a seasonal basis.

Large wood inputs will be quantified via annual surveys and mapping of the large wood debris within the stream reaches. Each year each piece of wood greater than 1.0 m length and 0.1 m diameter will be tagged with an aluminum tag, mapped on low level aerial photos and measured for diameter and length. New pieces will be noted each year as well as quantification of the movement and loss of older pieces.

Invertebrate communities in different riparian species (trees, shrubs, grasses, sedges):

Availability of terrestrial invertebrates in the riparian zone will be determined using a variety of techniques including pit traps, sticky traps and sweep nets. Litterfall nets placed below riparian vegetation will collect invertebrate infall that will be separated from vegetative inputs. Abundance will be determined by counting individual organisms and by drying collections for dry biomass. Because terrestrial invertebrates, primarily insects, are closely associated with host plant species, identification of these organisms will associate riparian plants important for their contributions to stream inputs. Subsequent analysis of fish diet via lavage techniques will determine terrestrial invertebrates important to native fishes.

Influence of allochthonous inputs of plant material to stream invertebrates:

To examine the utility of various tree and herbaceous plant species by aquatic invertebrates, leaf packs of monocultural and multiple species composition will be fastened to bricks and placed in focal sites for colonization by macroinvertebrates. Leaf packs will be removed at 2, 4, and 6 week intervals to determine biomass loss among leaves and to collect fauna which are using the leaf material at different stages of leaf decomposition (Benfield 1996). Seasonal variability will be studied at a limited number of sites by placing seasonally typical inputs (e.g. catkins in spring, leaves and berries in summer, dormant leaves in autumn) into the stream. Associated physical variables important to rates of decomposition such as temperature and flow will be measured during these intervals. In addition to a variety of native plants common in the region, non-native species, including hybrid poplar and Russian olive, will be included in leaf packs to examine the potential influence of these plants in the aquatic food web.

A variety of techniques will be used to measure changes in biomass, diversity, and feeding guilds of stream macroinvertebrates. The study design will provide the opportunity to compare these measures for differences in riparian species, and input phenologies. At each site, six replicate benthic collections will be made with a 0.09 m^2 Surber sampler, stored in 70% ethanol (Hauer and Resh 1996), and enumerated under a laboratory microscope. Visual counts of large-bodied invertebrates, generally herbivores, will be made using a 0.1 meter water scope (Li 1990). Five transects perpendicular to flow, extending over the wetted channel width, will be randomly chosen for each site; counts will be made at 1 meter intervals along each transect. In the first year, collections will be made at sites identified through analysis of aerial photographs and preliminary reconnaissance as representative of different riparian vegetation. Subsequent years will expand sampling to include early and late sampling dates, and a represent a wider variety of riparian diversity.

Stream drift: invertebrates, allochthonous and autochthonous contributions: Four replicate drift samples will be collected at each site several times/seasonal. Nets (1000 micron mesh nested within 363 micron mesh to separate coarse fractions from fine) will be set for equal periods of time and water velocity will be measured upstream of each net in order to calculate the volume of water being filtered. Aquatic and terrestrial invertebrates will be separated from the detrital material and identified. Invertebrates will then be dried and biomass calculated. Voucher specimens will be retained in the OSU Department of Entomology. Detrital material will be separated into categories and percent of each leaf type comprising the sample will be quantified before being dried (55^0C) and ashed (550^0C) (Johnson and Covich 1997).

Measurements of stream morphology and habitat complexity:

We will use a combination of ground surveys and low-altitude remote sensing to quantify and characterize stream morphology and habitat complexity. Ground surveys will be conducted using the Hankin and Reeves (1988) methodology to quantify fish habitat and its distribution within the study reaches. We will quantify and delineate the distribution of habitat types, substrate conditions, woody debris, undercut banks, large pools, and off-channel habitats from the ground surveys. Detrital retention will be estimated with standardized leaf and particle releases. Low-altitude remote sensing will be conducted with a helicopter using a forward-looking infrared (FLIR) thermal imager and digital color day video. The FLIR will be used to map the longitudinal temperature profiles and thermal heterogeneity of the study streams (Torgerson et al. 1996). Temperature change within the study reaches will be standardized by reach length and aspect. We will use the visible video to digitize stream channels and to provide the base GIS coverage's for all the study datasets. All datasets will be geo-referenced using GPS and attached to an Arc/Info GIS. These data layers will provide the habitat template for fish studies in these reaches.

Measurements of fish responses associated with food and habitat quality:

We will use empirical measurements of fish density, analyses of stomach contents and growth rate of young-of-the-year (YOY) fishes to rate habitats associated with riparian diversity. Fish density census will be conducted according to Li et al. (1994). Stomach contents will be collected using lavage techniques as described by Bowen (1983) and analyzed following the procedures of Gelwick et al. (1997). Growth rates will be calculated by nondestructive sampling of YOY fishes during early October. We will use changes in length and the ratio of body depth/total length as indices of growth and condition. Fish will be captured, constrained in half tubes and photographed from a fixed distance. We will use logistic regression to classify fish habitat quality and use multiple regressions to examine correlations of riparian diversity, riparian density, and riparian extent to growth rates, stomach fullness, and fish density.

f. Facilities and equipment.

Computers: 10 Pentium PC personal computers, 2 McIntosh 8100 computers. 4 printers, scanner, 2 data servers and complete connection to email and the internet
GIS: a complete GIS laboratory, including digitizers, work stations, ArcView, ArcInfo, and frame grabbing GIS software, GPS units, and digital video cameras
Software: Word, WordPerfect word processors, Excell and quatro-pro spreadsheets, SAS and BMDP statistical packages, Procite and Absearch bibliographic software.
Field Equipment: We are well equipped. 3 travel trailers, flow meter, 40 recording thermisters, snorkeling gear, electrofishers, underwater cameras, 3 field vehicles, aquatic insect collecting gear, solar pathfinders and equipment to measure vertical hydraulic gradients, surveying station, boats, first aid kits, cellular phones.
Analytical laboratories: We have 2 well equipped analytical laboratories and a laboratory for sorting and identifying invertebrates. We have available one binocular, dissecting microscope; and image analyzers. Proposal includes request for an updated microscope to facilitate extensive time for invertebrate and fish gut analyses.
University Facilities: The university provides, offices , communications, photocopying, book keeping services, and university library.

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Sweeney, B.W. 1993. Effects of streamside vegetation on macroinvertebrate communities of White Clay Creek in eastern North America. Proceedings of the Academy of Natural Sciences of Philadephia 144: 291-340.

Swift, B.L. 1984. Status of riparian ecosystems in the United States. Water Resources Bulletin 20: 223-228.

Torgerson, C.E., N.J. Poage, M.A. Flood, D.J. Norton, and B.A. McIntosh. 1996. Airborne thermla remote sensing of salmonid habitat for restoration planning in Pacific Northwest watersheds. In: Proceedings of Watershed 96, June 1996, Baltimore, MD. Water Environment Federation.

Section 8. Relationships to other projects

The investigators for this project are involved in several on-going studies in eastern Oregon, funded by the BLM, USFS, NSF, and ODFW. These studies are focused on a variety of issues related to watershed condition and restoration, riparian zones, and fish habitats. Specifically, we are examining geomorphic, hydrologic and ecological connectivity in eastside watersheds; the ecology of native fishes and macroinvertebrates; stream temperatures; and the role of livestock on riparian vegetation, soils and channel structure. Past and on-going research results will be useful to this proposed project.

Section 9. Key personnel

JUDITH L. LI

Commit 0.25 FTE to Project

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Assistant Professor
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EDUCATION:
A.B. - Biological Science, University of California, Berkeley, 1966; **M.S. -** University of California, Davis, 1977; **Ph.D.Fisheries,** Oregon State University, Corvallis, 1990.

EXPERIENCE:
Research Assistant Professor, OSU Department of Fisheries and Wildlife /Department of Entomology January 1997-present; **Research Assistant Professor**, OSU Department of Fisheries and Wildlife (March 1994-1996); Principal Investigator, EPA Surface Waters Program, Development of Macroinvertebrate Sampling Protocols in Western Oregon (1992-1994); **Research Associate**, OSU Department of Fisheries and Wildlife (1991-1994); **Research Director**, Oregon Museum of Science and Industry, NSF Young Scholars Program Aquatic Team (1990, 1993).

EXPERTISE:
Dr. Li is a stream ecologist whose emphasis has been on freshwater invertebrates and their role in aquatic foodwebs. She has been involved in multidisciplinary research in eastern Oregon for 10 years through projects funded by competitive grants from NSF, USFS, and EPA. She has been developing landscape models of macroinvertebrate assemblages for the Inner Columbia River Basin Report (USFS and BLM) and the Willamette Basin (EPA-sponsored PNW Consortium). With her students she has been examining the influence of human activities on aquatic biota in river basins affected by mining, intense recreation, grazing and agriculture.

PROFESSIONAL ACTIVITIES:
North American Benthological Society: Member Executive Committee (1991-1992;1994-1997); Chair, Task Force on Multicultural Diversity (1991-1994); Chair, Human Relations Committee (1994-present); **American Fisheries Society** :Member, J. Frances Allen Scholarship Committee, (1994-1997); Chair, Education and Information Committee, Oregon Chapter (1991-1994; 1997).

HONORS AND AWARDS:
OSU College of Agriculture, Oldfield Team Research Award (1991); **Nominee, OSU College of Agriculture: Presidential Award of Excellence in Science, Mathematics and Engineering Mentoring, National Science Foundation** (1996);

Special Recognition by American Women in Science as a mentor for women, 25th Anniversay Celebration, OSU, Jan 14, 1997; **Nomination, Women of Achievement Award,** April 25, 1997; Women's Center OSU

FIVE PUBLICATIONS RELATED TO THIS PROPOSAL :

Li, H.W., G.A. Lamberti, T.N. Pearsons, C.K. Tait, J.L. Li. 1994. Cumulative impact of riparian disturbance in small streams of the John Day Basin, Oregon. Transactions of the American Fisheries Society 123(4):627-640.

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Li, H.W. and J.L. Li. 1996. Fish Community Composition. Pages 391-406 *in* F.R. Hauer and G.A. Lamberti (eds). Methods in stream ecology. Academic Press, N.Y., N.Y.

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Herlihy, A., P Kaufmann, L. Reynolds, J. Li, and G. Robison. 1997. Developing indicators of ecological condition in the Willamette Basin: an overview of the Oregon prepilot study for EPA's EMAP Program. pp. 275-282. *In* River quality, dynamics, and restoration. A. Laenen and D.A. Dunnette (eds.), CRC Press, Boca Raton, FL.

Sherri L. Johnson

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EDUCATION:

BA - Environmental Biology, University of Montana, Missoula, 1989: **MS - Zoology**, University of Oklahoma, Norman, 1991: **Ph.D. - Zoology**, University of Oklahoma, Norman, 1995.

EXPERIENCE:

Research Associate, Department of Geosciences, Oregon State University, 1996-present; **Research Scientist,** Department of Zoology, University of Oklahoma, 1995-1996.

EXPERTISE:

Dr. Johnson is a stream ecologist who has conducted successful research examining riparian controls of allochthonous distributions at multiple spatial and temporal scales along river gradients. Research has focused on biotic responses to physical disturbances (floods, hurricanes, human activities) through changes in availability of food resources and habitats. Her current research involves analysis of terrestrial/stream interactions (geomorphic analysis of flood induced channel changes as well as examination of controlling mechanisms of stream temperatures). She is presently teaching stream ecology and limnology at OSU.

HONORS AND AWARDS:
National Science Foundation Post-doctoral Fellow, 1996-1998; University of Oklahoma Centennial Research Fellowship, 1991-1995.

FIVE PUBLICATIONS RELATED TO THIS PROPOSAL:

S.L. Johnson and A.P. Covich. 1997. Scales of observations of riparian forests and distributions of suspended detritus in a prairie river. **Freshwater Biology** 37: 163-175.

S.L. Johnson and C.C. Vaughn. 1995. A hierarchical study of macroinvertebrate recolonization of disturbed patches along a longitudinal gradient in a prairie river. **Freshwater Biology** 34:531-540.

S.L. Johnson, G.E. Grant, F.J. Swanson, and B.C. Wemple. 1997. Lessons from a flood: an integrated view of the February 1996 flood in the McKenzie River basin. Pages 159-167 *in* A. Laenen (ed.) The Pacific Northwest Flood of February 1996, Proceedings of the Pacific Northwest Water Issues Conference, American Institute of Hydrology, .

S.L. Johnson. 1993. Cover choice by bluegills: Orientation of underwater structure and light intensity. **Transactions of the American Fisheries Society** 122:148-154.

A.P. Covich, T.A. Crowl, S.L. Johnson, and M. Pyron. 1996. Distribution and abundance of tropical freshwater shrimp assemblage along a stream corridor: response to disturbance. **Biotropica** 28:484-492.

HIRAM W. LI

Commit 0.25 FTE to Project

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Professor and Assistant Leader
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EDUCATION:
A.B. - Zoology, University of California, Berkeley, 1966; **M.S. - Fishery and Wildlife Biology**, Colorado State University, 1973; **Ph.D. - Ecology,** University of California,

Davis, 1973.

EXPERIENCE:

Professor and Assistant Leader, Oregon Cooperative Fishery Unit, Department of Fisheries and Wildlife, Oregon State University. 1988-Present; **Associate Professor and Assistant Leader**, Oregon Cooperative Fishery Unit, Department of Fisheries and Wildlife, Oregon State University. 1979 to 1988; **Assistant Professor**, Department of Wildlife and Fisheries, University of California, Davis. July 1973 to January 1979.

EXPERTISE:

Dr. Hiram Li's nationally recognized expertise is in the community ecology of freshwater fishes, as well as landscape and stream ecology. He has spent the past decade doing research in the Blue Mountain Ecoregion examining the relationship of riparian condition and its relationship to the ecology of salmonid bearing streams.

PROFESSIONAL ACTIVITIES:

Ecology Advisory Panel for the National Science Foundation 1984-1987; **Associate Editor** for Transactions of the American Fisheries Society 1986-1988; **Foley-Hatfield Congressional Team** on Eastside Forest Health Assessment, 1992-1993; **Referee** for 14 primary journals

HONORS AND AWARDS:

Commendation Award, Sport Fishing Institute (1978); **Quality Performance Awards,** U.S. Fish and Wildlife Service (1982, 1989, 1990, 1991); **Director's Research Excellence Award**, U.S. Fish and Wildlife Service
(1991); **Special Achievement Award**, U.S. Fish and Wildlife Service (1992, 1993, 1994); **Outstanding Group Achievement Award, American Institute of Fishery Research Biologists** (awarded to the Cooperative Fish and Wildlife Research Units) (1992)

FIVE PUBLICATIONS RELATED TO THIS PROPOSAL :

Li, H.W., G.A. Lamberti, T.N. Pearsons, C.K. Tait, J.L. Li. 1994. Cumulative impact of riparian disturbance in small streams of the John Day Basin, Oregon. Transactions of the American Fisheries Society 123(4):627-640.

Bayley, P.B. and H.W. Li. 1992. Riverine Fishes. Chapter 12. Pages 251-281 in P. Calow, G.E. Petts (eds.). The Rivers Handbook, Hydrological and Ecological, Volume 1. Blackwell Scientific.

Li, H.W. , K. Currens, D. Bottom, S. Clarke, J. Dambacher, C. Frissell, P. Harris, R.M. Hughes, D. McCullough, A. McGie, K. Moore, R. Nawa, and S. Thiele.1996. Safe havens: genetic refuges and evolutionary significant units. Pages 371-380, *in* J. Nielsen (ed.), Evolution and the aquatic Ecosystem: Defining unique units in population conservation. American Fisheries Society. Bethesda MD.

Tait, C.K., J.L. Li, G.A. Lamberti, T.N. Pearsons, and H.W. Li. 1994. Relationships between riparian cover and the community structure of high desert streams. Journal of the North American Benthological Society 13(1):45-56.

Li, H.W. and J.L. Li. 1996. Fish Community Composition. Pages 391-406 *in* F.R. Hauer and G.A. Lamberti (eds). Methods in stream ecology. Academic Press, N.Y., N.Y.

Note: See above for papers and manuscripts related to remote sensing, FLIR and salmonid research.

BRUCE A. MCINTOSH

Commit 0.25 FTE to project

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EDUCATION:
B.S. - Wildlife Biology, University of Montana, Missoula, 1982; **M.S. - Forest Ecology**, Oregon State University, Corvallis, 1992; **Ph.D. - Forest Ecology**, Oregon State University, Corvallis, 1995.

EXPERIENCE:
Research Associate, Department of Forest Science, Oregon State University. 1995 - Present; **Research Assistant**, Department of Forest Science, Oregon State University. 1992 - 1995.

EXPERTISE:
Dr. McIntosh has been conducting research on riverine ecosystems and salmonid habitats in the Columbia River basin for the past nine years. His research has focused on historical changes in riparian and stream habitats, salmonid life history, and the use of remote sensing for stream and riparian research and monitoring. In addition, he has been involved in several assessments of eastside ecosystems for the Federal Government.

FIVE PUBLICATIONS RELATED TO THIS PROPOSAL:
McIntosh, B.A. 1995. Historical changes in stream habitats in the Columbia River basin. Ph.D. dissertation. Corvallis, OR: Oregon State University. 175 pp.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Historical changes in fish habitat for select river basins of eastern Oregon and Washington. Northwest Science, 68 (Special Issue):36-53.

McIntosh, B.A., N.J. Poage, and K. Ronnenberg. 1996. Identification and mapping of stream temperatures in the Illinois River basin using forward-looking infrared technology. Final report to the Rogue Valley Council of Governments, Cave Junction, OR. 27 pp.

Torgerson, C.E., N.J. Poage, M.A. Flood, D.J. Norton, and B.A. McIntosh. 1996. Airborne thermla remote sensing of salmonid habitat for restoration planning in Pacific Northwest watersheds. In: Proceedings of Watershed 96, June 1996,

Baltimore, MD. Water Environment Federation.
Karalus, R.S., M.A. Flood, B.A. McIntosh, and N.J. Poage. 1997. ETI surface water quality monitoring technologies demonstration. Final report to the Environmental Protection Agency, Characterization Division, Las Vegas, NV. 86 pp.

J. BOONE KAUFFMAN

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EDUCATION:
B.S. - Range and Wildlife Science, Texas Tech University, Lubbock, 1978; **M.S. - Rangeland Resources,** Oregon State University, Corvallis, 1982; **Ph.D. Wildland Resource Science/Forest Ecology,** University of California, Berkeley, 1986.

EXPERIENCE:
Associate Professor Dept. of Fisheries and Wildlife, Oregon State University, 1995-present. Assistant Professor (1986-1991), Associate Professor (1991), Dept. of Rangeland Resources, Oregon State University, 1986-1995.

EXPERTISE:
Dr. Kauffman has been conducting research in riparian zone ecology for 20 years. Most of that research has been in Northeast Oregon. He also currently teaches the wetland and riparian ecology course at OSU. Research has focused on the plant ecology, biogeochemistry, and floodplain/stream interactions. His research has primarily been applied in nature with an emphasis on restoration ecology and how land use influences the dynamics of riparian/stream ecosystems. Dr. Kauffman has authored over 100 scientific papers.

PUBLICATIONS RELATED TO THIS PROPOSAL:
Elmore, W. and J. B. Kauffman. 1994. Riparian and watershed systems: Degradation and restoration. pp. 212-232. IN: Vavra, M., W. A. Laycock and R. D. Pieper (eds.). Ecological Implications of Livestock Herbivory in the West. Society for Range Management, Denver, CO.
Green, D. M. and J. B. Kauffman. 1995. Succession and livestock grazing in a northeastern Oregon riparian ecosystem. J. Range Management. 48:307-313.
Kauffman, J.B., N. Otting, D. Lytjen, and R.L. Beschta. 1996. Ecological Principles and approaches to riparian restoration in the Western United States. In: Healing the rivers. Pacific Rivers Council Eugene, OR.
Kauffman, J. B., R. L. Beschta, N. Otting, and D. Lytjen. 1997. An ecological

perspective of riparian and stream restoration in the western United States. Fisheries 22:12-24.
Case, R.L. and J. B. Kauffman. 1997. Wild ungulate influences on the recovery of willows, black cottonwood and thin-leaf alder following cessation of cattle grazing in Northeastern Oregon. Northwest Science 71:115-125.

GARY L. REED

Commit 0.10 FTE to project

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EDUCATION:
B.S. - Entomology, Iowa State University, Ames, IA, 1965; **M.S. – Entomology** (ecology), Iowa State University, 1970; **Ph.D. - Entomology**, Iowa State University, 1974.

EXPERIENCE:
Superintendent & Research Entomologist, Hermiston Agricultural Research & Extension Center, Oregon State University, 1985-Present. **Research Entomologist**, Agricultural Research Service, U.S. Department of Agriculture, 1970-1974. **Research Entomologist,** 1968-1970.

EXPERTISE:
Dr. Reed has extensive understanding of terrestrial invertebrate communities of Northeastern Oregon. His research has focused on human influences on invertebrate densities in agricultural settings. He has examined the impact of integrated pest management control mechanisms on agronomic pest species and on non-target invertebrates in the crop ecosystem as well as conducted research on the impact of insecticides .

PUBLICATIONS:
52 refereed journal articles and 70 plus non-referred and popular technical articles

Section 10. Information/technology transfer

We will transfer information through the following means:

Refereed publications; graduate student theses.

Presentation of papers at local, regional and national scientific meetings.

College of Agriculture and College of Forestry bulletins and publications, including those of the OSU Extension program.

We plan to be involved with local watershed councils and to present results of our work in a timely fashion.

We will explore ways in which to transfer scientific findings in print and potentially electronic forms that will be easily understood by landowners and decision makers.

We believe the interpretation of aerial photographs, historical reconstructions, plant succession in riparian zones, and litter input transfer to aquatic invertebrates and fish lend themselves well to visual presentation for many audiences.