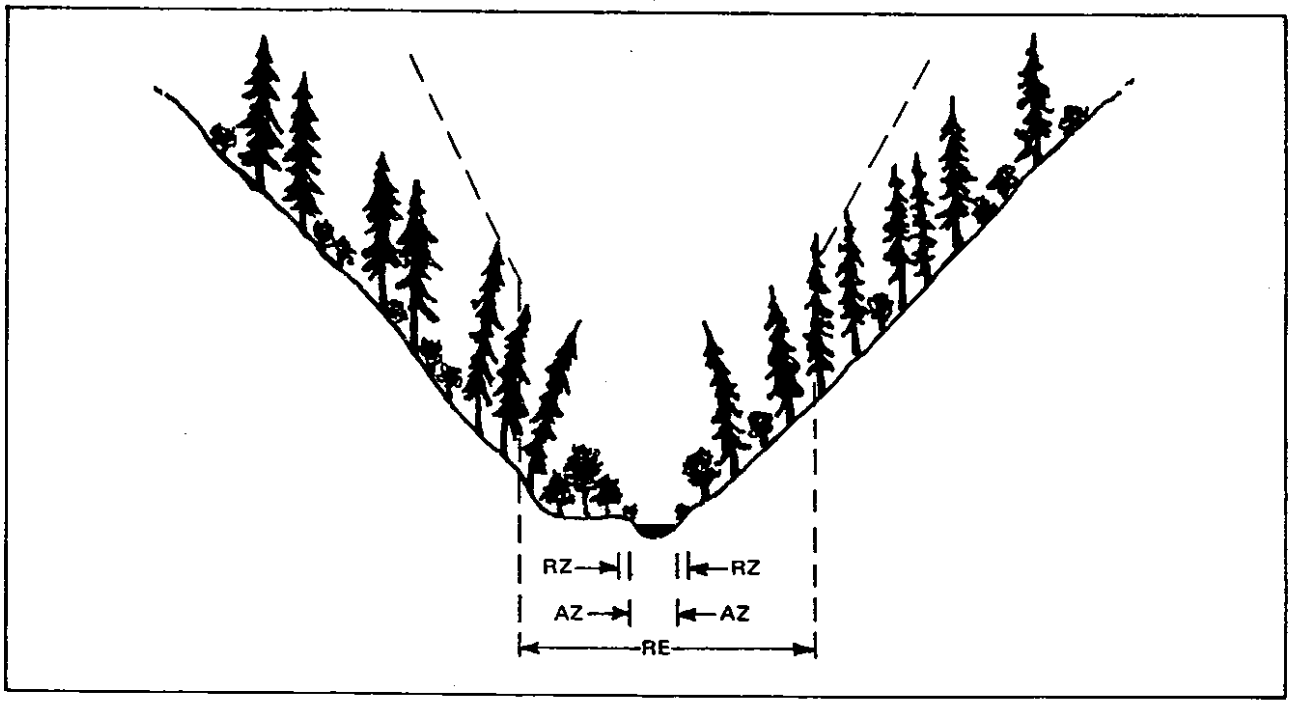
FOREST
RIPARIAN HABITAT STUDY
PHASE I REPORT



CROSS–SECTIONAL DIAGRAM OF RIPARIAN ECOSYSTEM

Prepared For: Washington Forest Practices Board

By: Riparian Habitat Technical Committee

State of Washington

Booth Gardner

Governor

WDOE 85-3

April, 1985

Department of Ecology

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Director

FOREST RIPARIAN HABITAT STUDY

PHASE I REPORT

PREPARED FOR THE WASHINGTON FOREST PRACTICES BOARD

BY THE RIPARIAN HABITAT TECHNICAL COMMITTEE

April, 1985

Olympia, Washington

KEY WORDS: FISH MANAGEMENT, WILDLIFE, FOREST PRACTICES
RIPARIAN

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This report is the result of efforts by individuals representing varied expertise and professional interests. They represent state, federal and Indian agencies, the forest industry and the public. The innumerable hours devoted to this study by these individuals, who have other full-time occupations, reflects their commitment to the fish, wildlife and forest resources of this State. Such a commitment is also reflected by the parent organizations who have made the time of these individuals available.

Special mention is made of Maureen Beckstead, Washington Department of Game (formerly U.S.D.A. Forest Service), and Steve Keller, Washington Department of Fisheries. Their contribution to this project as leaders of sub-committees and authors made the completion of this report possible.

Graphics for this report have been prepared by John Milhollin, Washington Department of Ecology.

PREFACE

During this study, it was our goal to reach agreement (i.e. consensus) on the interpretation of information reported in the literature. Agreement was often achieved during initial work to identify the characteristics of riparian ecosystems, how, and to what extent fish and wildlife use these ecosystems. Agreement became more difficult, however, during our analysis of the extent to which forest practices can change riparian ecosystems. This was due, in large part to, the complexity of issues involved and conflicting evidence reported in the literature.

In order to complete this phase of the study and provide a product to the Forest Practices Board, we agreed to disagree on certain issues. Those members of the Riparian Habitat Technical Committee who judged that an interpretation held by the majority of committee members was inadequate were invited to prepare statements presenting their alternative positions. Position statements are found at the end this report and the author of each is identified.

It is to be hoped that this approach will be useful to Board members and maintain a sense of fairness among technical committee members.

James A. Sachet
Chairman, Riparian Habitat
Technical Committee
April, 1985

EXECUTIVE SUMMARY

INTRODUCTION

Public testimony received on proposed revisions to the Washington Forest Practices Rules and Regulations in 1981 indicate a concern that forest practices regulations may not adequately protect fish and wildlife habitat in riparian areas. State Forest Practices Board (FP Board) members agree that additional information is needed before decisions can be made regarding changes to regulatory programs.

The FP Board directed that a study be completed to determine the nature and extent of fish and wildlife uses of riparian habitat and what changes occur as a result of forest management activities.

This report presents the findings of the first phase of study - an examination of riparian habitat requirements and changes caused by forest practices. The second phase is to identify what specific steps are available to improve habitat management. Initiation of the second phase is subject to FP Board action following consideration of this first phase report.

STUDY OBJECTIVES, SCOPE, METHODS AND LIMITATIONS

Objectives

Specific objectives are to:

a. determine the characteristics and uses of forest riparian areas in Washington;

b. describe existing conditions including the type and extent of riparian habitats occurring and changes in riparian habitats caused by forest practices;

c. evaluate the changes in riparian habitats and determine whether such changes are beneficial or detrimental to fish and wildlife; and

d. report findings to FP Board members.

Scope

Those forest lands throughout Washington under the jurisdiction of the FP Board along waters classified as Type 1, 2, 3, 4, or 5 are included in this study.

We consider all native and introduced freshwater fish in the state. These are classified as salmonids (salmon, trout), spiny rays (bass, perch, sculpins), or other freshwater fish (e.g. sturgeon).

Wildlife include those native and introduced mammals, birds, reptiles and amphibians found in Washington. Invertebrates are excluded from consideration.

Methods

Our approach is to combine information available from literature with the experience and expertise of professional resource managers. A Riparian Habitat Technical Committee (RHTC), representing state and federal resource agencies, private industry and the public, forms the working group for conducting this investigation.

In general, fish habitat issues are separated from wildlife habitat issues and are dealt with by subcommittees of the RHTC. Forest management issues are examined by a forestry subcommittee.

Study Limitations

A lack of quantitative information is the largest hurdle in a study of this scope. For example, information is available regarding the occurrence and geographic range of wildlife species in Washington, however, abundance data (numbers of individual animals) is generally lacking for many species.

As a result, we use more general relationships between fish and wildlife biology, riparian habitat and forest practices. We identify structural and functional processes operating in riparian habitats. We also identify how fish and wildlife community composition changes with alterations of riparian vegetation by natural events or management activities.

RIPARIAN ECOSYSTEM CONCEPT

Most fisheries biologists stress that streams and the vegetation which directly influence instream processes form a single, functioning ecosystem. We use this concept of the riparian ecosystem to account for the multiple inter-relationships between waterbodies and adjacent vegetation.

For the purposes of this study, a riparian ecosystem is defined as:

An interacting natural system including, and adjacent to surface waters; including all the organic and inorganic elements contained in an aquatic zone, riparian zone, and direct influence zone. A riparian ecosystem contains the total of all environmental elements that directly contribute to the structural and functional processes of a body of water.

The direct influence zone is a band of vegetation adjacent to a riparian zone and includes trees that shade a stream or directly contribute coarse or fine woody debris to a stream.

The originators of the riparian ecosystem concept focus on anadromous fish habitat. We, however, also apply it to wildlife habitat in riparian environments.

STRUCTURAL AND FUNCTIONAL ROLES OF VEGETATION IN STREAMS

Vegetation growing near water provides a nearly constant rain of organic litter and terrestrial insects to an adjacent water body. This, in turn, contributes to the productivity of aquatic plant and animal life. Stream temperature and light penetration are affected by shade from nearby trees and shrubs. Roots of herbaceous and woody plants stabilize streambanks, retard erosion, and provide cover for aquatic animals.

Woody debris derived from tree mortality, blowdown, bank cutting, or mass soil movements serve important roles in streams. Woody debris can a) control routing of sediment and water, b) stabilize streambanks and shape stream channels, c) provide diversity in fish habitat by creating pools, riffles and patches of spawning gravel, d) provide hiding and rearing cover for fish and other aquatic animals, and e) contribute to the nutrient and energy production of streams as decomposition occurs.

BASIC HABITAT REQUIREMENTS OF FISH AND WILDLIFE

Animals interact with their environment to obtain food, water, cover and space necessary for survival, growth and perpetuation of their species. Basic fish habitat requirements include:

- water of good quality
- water quantity and flow
- waters that permit fish passage
- waters with substrate and cover for reproduction
- waters with riparian and instream cover
- waters that have adequate food.

Basic wildlife habitat requirements include:

- food and water
- cover for breeding and brooding
- cover for hiding and resting
- travel corridors
- thermal cover.

SIGNIFICANCE OF RIPARIAN ECOSYSTEMS AS HABITAT

Of the approximately 480 species of wildlife in terrestrial and shoreline habitats of Washington, 291 (60%) are found in wooded riparian habitats. In addition, 77 species of fish are found in fresh and intertidal waters of Washington. In regard to wildlife habitat, investigators in the Pacific Northwest have found that wildlife use riparian zones disproportionately more than any other type of habitat.

Fish and aquatic mammals are obviously dependent upon aquatic environments. The importance of riparian ecosystems is further evidenced by the types and number of wildlife species using riparian habitat.

Sixty-eight species of mammals, birds, amphibians and reptiles require riparian ecosystems to satisfy a vital habitat need during all or part of the year. Another 103 species are more numerous in riparian ecosystems, or use them more heavily than upland habitat. Twenty-two species of birds use open water within riparian ecosystems for resting and feeding.

According to our examination of wildlife uses of riparian ecosystems, 69 percent of the mammals and 63 percent of the birds found in riparian ecosystems either require or prefer them. This is also the case for 70 percent of the reptiles and amphibians found in riparian ecosystems.

Fish and wildlife habitat are directly related to the stand condition and species mix of the plant community occurring in a riparian ecosystem. This is because each plant community provides a specialized habitat or unique mix of vertical and horizontal structure, canopy cover, type and volume of detritus, and the type and configuration of edges.

Riparian ecosystems are heavily used by wildlife because their basic habitat requirements often occur in close proximity. Riparian habitats are distinguishable from upland habitats by the following characteristics:

a. the <u>presence of surface water</u> during all or part of the year;

b. in general, variable soil moisture conditions give rise to <u>more complex and diverse vegetation</u> which provides ground, shrub, and canopy habitats in one area;

c. <u>linear shape</u>, which is typically a continuous narrow band that borders or interconnects with upland habitats;

d. <u>various edges</u> or "meeting places" between a variety of intermixed plant communities or successional stages;

e. <u>high edge-to-area ratios</u> which is a measure of increasing diversity and richness of habitat types;

f. <u>microclimates</u> which differ from surrounding uplands because of topographic location and presence of water. Riparian ecosystems tend to have high humidity, high transporation rates and less variation in temperature extremes; and,

g. recurring disturbances resulting from flooding, erosion and deposition. These forces influence the structure and composition of riparian vegetation.

Life cycle requirements of fish cannot be separated from the aquatic ecosystem. All components of fish habitat are influenced either positively or negatively by the organic litter, woody debris, shade and erosion control provided by riparian vegetation.

Negative influences primarily occur from excessive contributions of woody debris which lead to fish passage problems or increased potential for debris torrents. In general, vegetation within riparian ecosystems has a positive influence because it is essential to maintain habitat diversity, food sources and good water quality.

The basic habitat requirements of wildlife are available in abundance in riparian ecosystems which have mature trees and a mix of plant communities where several edges and vertical and horizontal structures occur.

Food and Water: high quality food is plentiful because of the productivity and diversity of plant life. Many feeding areas are provided by stratification of vegetation horizontally along the length of a riparian ecosystem and vertically by ground cover, shrubs and brush, and trees. Water is present during all or part of the year.

Breeding and Brooding: trees, shrubs and ground cover are used for nesting and rearing habitat. Because of its diversity, riparian habitat satisfies the particular needs for brooding and rearing or young of many kinds of wildlife. Easy access from feeding to cover areas reduces mortality and exposure of young to predation and other environmental hazards.

Hiding and Resting: wildlife need places to escape in which to hide or rest. The diversity and distribution of vegetation and favorable topography in riparian ecosystems provide cover which is used daily or seasonally by resident and transient wildlife.

Travel: riparian ecosystems, because of their linear shape, are used as corridors by predators and large mammals. They are used daily or seasonally by wildlife to seek water, food or hiding and resting places.

Thermal Cover: the microclimates of riparian ecosystems result in moderate temperatures. Wildlife frequently seek these areas to reduce thermal stress from temperature extremes.

VARIBILITY IN RIPARIAN ECOSYSTEMS

Conditions in, and sizes of, riparian ecosystems change from one site to another along the length of a stream and over time at one site. Principal expressions of such changes are: 1) stream size - the production of energy and nutrients for an aquatic food web shift from out-of-stream to instream with varying stream size; 2) stream gradient and flow velocity; and 3) the composition, height and structure of riparian plant communities over time.

Spatial Variation

Small headwater streams (Type 4 and 5 in upland areas) are largely dependent upon input of small organic litter for energy supplies. On these headwater streams, herbs, shrubs, and small tree components are suppressed by overstory trees so that penetration by sunlight is limited.

Intermediate size streams (Type 3 and some Type 2) can have more fully developed flood plains with a greater expression of herb, shrub and small tree components. Where this occurs, streams have more open canopies and greater light penetration. As a result instream production by primary producers (algae and vascular plants) begins to appear as sunlight penetrates the canopy and reaches the water surface.

Larger streams (Type 2 and Type 1) typically have well developed flood plains with a full expression of riparian plant communities, and exposed water surfaces. Here, the shift from out-of-stream sources of litter for aquatic production to instream production is predominant.

The gradual change along the stream continuum is subtle and varies with climatic and physiographic conditions prevalent in an area. The shift from out-of-stream production to instream production occurs most often in Type 3 streams.

Variation Over Time

Temporal variation in riparian ecosystems occurs as a result of seasonal and storm related changes of water level and successional responses to severe disturbances of streamside and upslope vegetation. Flooding, fires and debris torrents may damage or destroy vegetation along the riparian corridor thereby initiating new successional stages from sprouting of residual trees and shrubs or invasion by other plants.

Our treatment of succession includes six idealized stages: 1) grass-forb; 2) shrub dominated; 3) pole-sapling dominated; 4) young forest; 5) mature forest; and, 6) old growth forest. In addition, we also identify a herbaceous stage and separate hardwood dominated communities from those dominated by conifers. Mixed hardwood and conifer communities frequently develop in riparian ecosystems, particularly along intermediate and large streams.

Frequent disturbances, plus the wet conditions in riparian zones give rise to plant communities to which permanent immaturity, in relation to succession, may be a prime characteristic. This is particularly the case on intermediate and large streams where openings in the forest overstory are created and maintained.

HABITAT CHANGES CAUSED BY FOREST PRACTICES

Assumptions

In our analysis of riparian habitat and forest practices, we make the following assumptions:

1. forest landowners and managers comply with the requirements of the Forest Practices Rules and Regulations; and,

2. forest riparian ecosystem contain plant communities with mature trees and a mix of vertical and horizontal strata.

List of Forest Practices

Forest practices are grouped under major categories of a) road and landing construction, b) timber harvest, c) site preparation, d) fuels management, and e) timber stand improvement. A forest practice/ riparian habitat issue which is not covered by current regulations is the indirect cumulative effects in riparian ecosystems.

Changes Caused by Forest Practices

For convenience, we have separated fish habitat issues from those relating to wildlife habitat. In any case, the degree of change is related to the intensity and areal extent of the forest practices being conducted, and the types of fish and wildlife using a given area.

Differences in stand species composition and stand denities often indicate forest management objectives and systems which will by used by managers. Clearcut harvesting is common in the Douglas fir/ western hemlock region of western Washington while partial cut harvesting is the preferred method in the Ponderosa pine region of eastern Washington.

Changes in Wildlife Habitat

Dominant changes in riparian wildlife habitat include:

- alteration of the amount, kind and distribution of wildlife cover;
- alteration of the amount, kind and distribution of wildlife food;
- reduced number of snags;
- reduction in the amount, distribution of large downed woody debris;
- alteration of travel or access to water; and,
- increased disturbances/ harassment of animals by humans.

Changes in Fish Habitat

Dominant changes in riparian fish habitat include:

- alteration of shape and structure of stream channel due to loss of instream woody debris;

- alteration of stream channel shape, stability, streamside vegetation and water quality due to mass soil movements;

- alteration of fish habitat from increased sediment in water and within streambeds due to surface erosion and instream construction;

- alteration of water temperature regime due to removal of streamside vegetation and slash burning;

- alteration of fish passage and aquatic habitat at stream crossings or where roads parallel streams in riparian ecosystems;

- increased use of riparian ecosystems by humans due to increased access;

- alteration of aquatic productivity due to increased solar radiation; and,

- alteration of nutrient processing due to removal of streamside vegetation.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations of the RHTC are presented in Chapter 5 of this report.

CHAPTER I

STUDY OBJECTIVES, SCOPE, METHODS, LIMITATIONS

The Washington State Forest Practices Board (FP Board) is the rule making authority for forest practices on non-federal lands in the state. The FP Board, on March 31, 1982, approved a directive to "conduct a technical examination of fish and wildlife habitat requirements in stream riparian areas" (1).

Following approval of this directive, a technical committee was formed by the initiation of representatives of the Washington departments of Ecology and Natural Resources. The technical committee (to be described later) assisted in the development of a study workplan. On November 16, 1982, FP Board members approved the study workplan (Appendix D) with the following additions and clarifications:

1. That a broad-based review of available information be conducted to determine the biological relationships between fish and wildlife and the elements of their forest riparian habitats;

2. Upon determination that sufficient biological information is available, that a determination be made of those beneficial and detrimental changes, or tradeoffs, caused by forest management activities;

3. If such changes cannot be determined that information needs be identified for future study;

4. If such changes can be determined, that methods be identified to reduce adverse changes; and,

5. That the study be separated into two phases whereby the first phase consider biological relationships of concern and the second phase examine forest practices to manage adverse changes.

This report presents the findings of the first phase, biological relationships of fish and wildlife, and riparian habitats in nonfederal forests. Specific terms are used in this report which may be unfamiliar to the reader. The "GLOSSARY" section, on pages 87 to 89, contains definitions of selected terms.

OBJECTIVES

Study objectives were to:

a. determine the characteristics and uses of forest riparian areas in Washington;

b. describe existing conditions including the type and extent of riparian habitats occurring and changes in riparian habitats caused by forest practices;

c. evaluate the changes in riparian habitats and determine whether such changes are beneficial or detrimental to fish and wildlife; and

d. report findings to FP Board members.

SCOPE

The geographic scope of this study includes those forest lands under the jurisdiction of the FP Board along water classed as Type 1, 2, 3, 4, and 5 (2). The FP Board's jurisdiction includes all private, state, and other nonfederal lands capable of supporting a merchantable stand of timber. Lands under another use such as agriculture or urban development are excluded from this forest land base.

Fish species considered during this study include all native and introduced freshwater fish in the state. Fish species are grouped as follows; salmonids (salmon, trout), spiny rays (e.g. bass, perch, sculpins), and all other freshwater fish.

Wildlife species include native and introduced mammals, birds, amphibians, and reptiles. Invertebrates, insects for example, are recognized as important members of the wildlife community, but are excluded from consideration other than as sources of food for higher order animals.

STUDY METHODS

In this study we combine the information available in scientific literature with the experience of professional resource managers. A Riparian Habitat Technical Committee (RHTC) was formed in May 1982.

Members of this group were selected based upon: a) training and knowledge of fish and wildlife biology, forest management, and water quality planning; and b) representation of major interest groups in the study subject. We were fortunate to acquire the services, on a volunteer basis, of 12 individuals which met these requirements (Table 1).

RHTC members assisted in the development of the study approach and preparation of a workplan. Following approval of the workplan by the FP Board, four major steps were undertaken (Table 2).

Three sub-committees of the RHTC have been created for the purposes of compiling available research and management information, assessing such data, then reassembling the information in a format usable for this report. Sub-committees are; wildlife, fisheries, and forestry.

Sub-committee members have been assisted by outside experts. Subjects such as warm water fisheries biology and management required expertise outside that available from RHTC members.

TABLE 1. RIPARIAN HABITAT TECHNICAL COMMITTEE

Representing	Member	Expertise/Training
Washington Department of Game	Beckstead, M.	Wildlife Biology
Forest Industry	Berg, S.	Forest Management
Washington Department of Natural Resources	Bigger, D.	Forest Management
Washington Department of Natural Resources	Cederholm, J.	Fisheries Biology
Public	Dziedzic, E.	Wildlife Biology
U.S. Fish & Wildlife Service	Kaumheimer, D.	Fisheries Biology
Washington Department of Fisheries	Keller, S.	Fisheries Biology
U.S. Forest Service	LaRoch, R.	Forest Hydrology
Northwest Indian Fisheries Commission	McDonald, D.	Fisheries Biology
Washington Department of Game	Mudd, D.	Wildlife Biology
Forest Industry	Rochelle, J.	Wildlife Biology
Washington Department of Ecology	Sachet, J.	Water Quality

TABLE 2. RIPARIAN HABITAT STUDY - MAJOR STEPS

Step	Purpose
Develop background information and describe riparian areas	To identify information needs and sources of available information; to develop common understanding of the characteristics of riparian areas
Identify fish and wildlife uses of riparian habitat	To determine general habitat requirements and levels of use of riparian habitats
Classify riparian plant communities, animal communities, and succession of of vegetation	To focus study by grouping commonly occurring plant and animal communities
Identify biological changes in plant and animal communities, and successional stages as a result of forest practices	To identify the processes by which forest practices change riparian habitat

Sub-committees and the full RHTC operated on a consensus basis when decisions were necessary. By consensus, it is meant that general agreement by all members was achieved. For example, it was a consensus opinion of all RHTC members that the riparian ecosystem concept adequately accounted for the physical and biological interactions that occur between streams and adjacent vegetation.

When consensus could not be achieved on specific issues, position statements were prepared by those dissenting from the majority interpretation. Position statements have been included at the end of this report.

The development of study findings occurred primarily at the sub-committee level. Findings of sub-committees have been discussed by the full RHTC, at which time questions were allowed regarding thoroughness, accuracy of data, format, etc.. The content, however, of a sub-committee's findings was not changed through this process.

STUDY LIMITATIONS

The largest hurdle in a study of this scope is the lack of quantitative information. Three examples illustrate this point. First, timber type inventories are typically either very specific which do not allow easy compilation of data over large areas, or are generalized so that riparian areas cannot be separated from upland areas. Second, occurrence and range information is available for a large number of wildlife species in Washington, however, abundance information (numbers of animals in an area) is not readily available. Third, even the total number of stream miles, either by water type or stream order, have not been accurately measured in this state.

As a result, we use the more general relationships between habitat changes induced by forest practices and the effects on fish and wildlife living in stream and riparian areas. Accurate predictions, therefore, of the numbers of animals affected by particular forest practices are not attempted.

We identify general structural and functional processes operating in riparian habitats. In addition, we identify how fish and wildlife community composition changes with the alteration of riparian vegetation and give examples of how species may respond.

The study workplan called for field studies, where possible, to verify changes in plant and animal communities caused by forest practices. No field studies have been conducted during this study. This is because: a) to be objective, long-term studies are typically necessary to identify cause and effect relationships; b) no funding has been available for this study.

CHAPTER 2

CHARACTERISTICS OF FOREST RIPARIAN ECOSYSTEMS

In this chapter, we discuss the roles of riparian vegetation as a component of fish and wildlife habitat, the concept of the riparian ecosystem, distinguishing characteristics of riparian habitats, and variability of conditions which occur along the length of a stream or over time as plant communities grow and develop. An estimate of the area of land involved in riparian areas on nonfederal forest lands is also presented.

RIPARIAN ECOSYSTEM CONCEPT

Conventional definitions of riparian zones restrict the focus of attention to the narrow band of plant communities adapted to wet sites (saturated soils) or other specific soil, water, or geographic conditions, (Figure 1). In order to account for the range of physical and biological interrelationships between riparian vegetation and adjacent water bodies, the RHTC uses the concept proposed by Meehan et al. (4) and Swanson et al. (5). They view streams and the vegetation which directly influences instream processes as a single ecosystem.

Within the context of this study, a riparian ecosystem includes the aquatic zone, riparian zone, and direct influence zone (Figures 2 and 3). The riparian ecosystem concept, then, gives us a framework for discussing fish and wildlife habitat and the major relationships which shape that habitat in riparian areas.

For the purposes of describing species diversity (Chapter 3) and assessing forest practices induced changes (Chapter 4), we visualize a baseline condition for riparian habitat as areas with a variety of large and small trees, shrubs, and ground vegetation arranged in complex vertical and horizontal structures. Riparian habitats contain irregularly distributed small openings and relatively large volumes of dead wood, both standing and down.

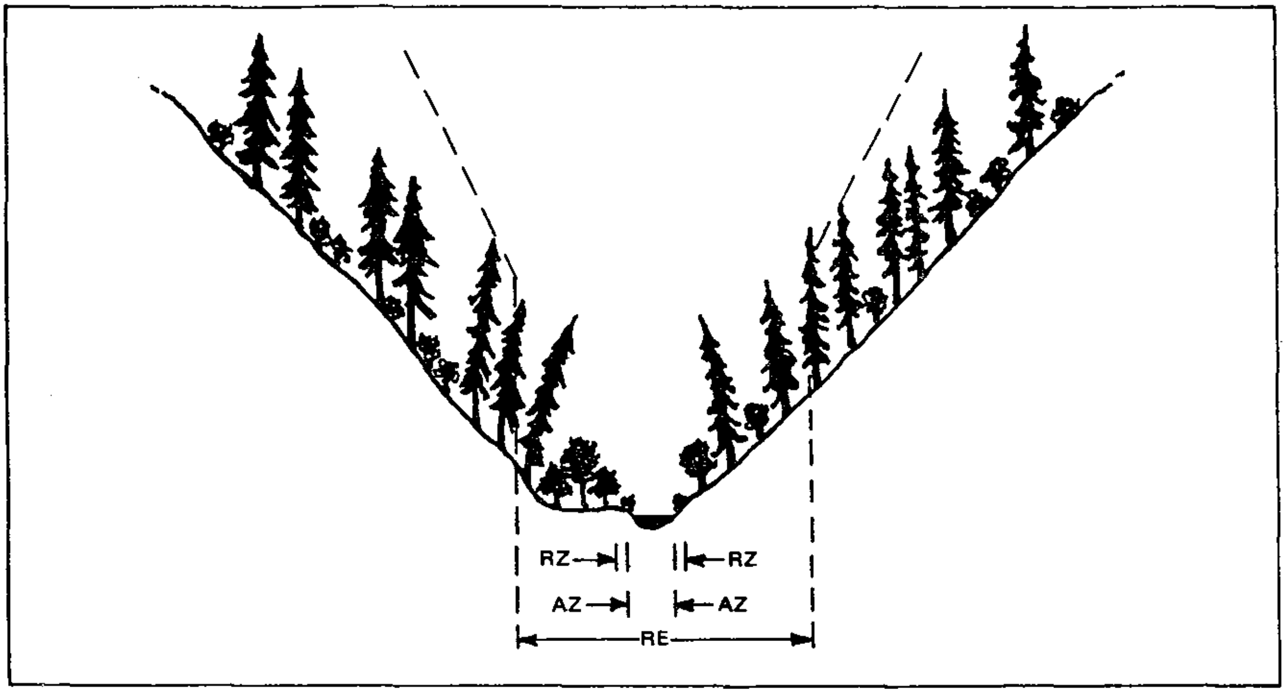


Figure 1. CROSS–SECTIONAL DIAGRAM OF RIPARIAN ECOSYSTEM – SIMPLE

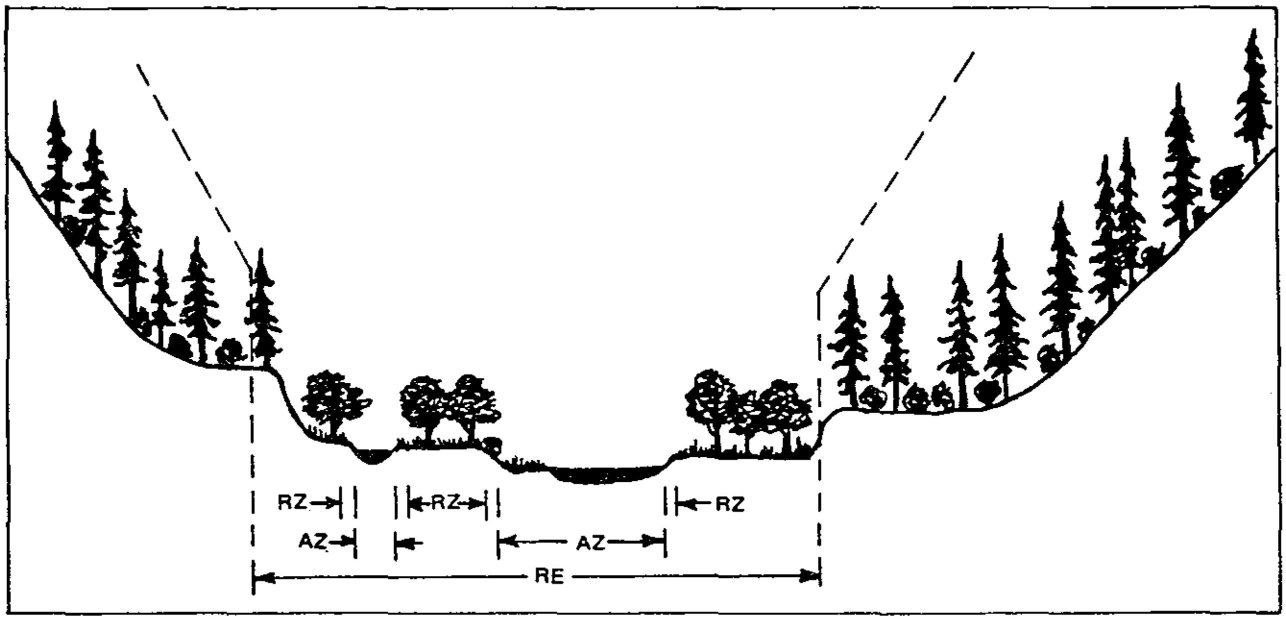


Figure 2. CROSS–SECTIONAL DIAGRAM OF RIPARIAN ECOSYSTEM – COMPLEX

AZ – Aquatic Zone
RZ – Riparian Zone
RE – Riparian Ecosystem

Figures 1 & 2. DIAGRAM OF RIPARIAN ECOSYSTEM SHOWING THE RELATIONSHIP BETWEEN THE AQUATIC ZONE, RIPARIAN ZONE, RIPARIAN ECOSYSTEM AND ADJACENT LAND AREA. (Adopted from: USDA Forest Service; Olympic National Forest)

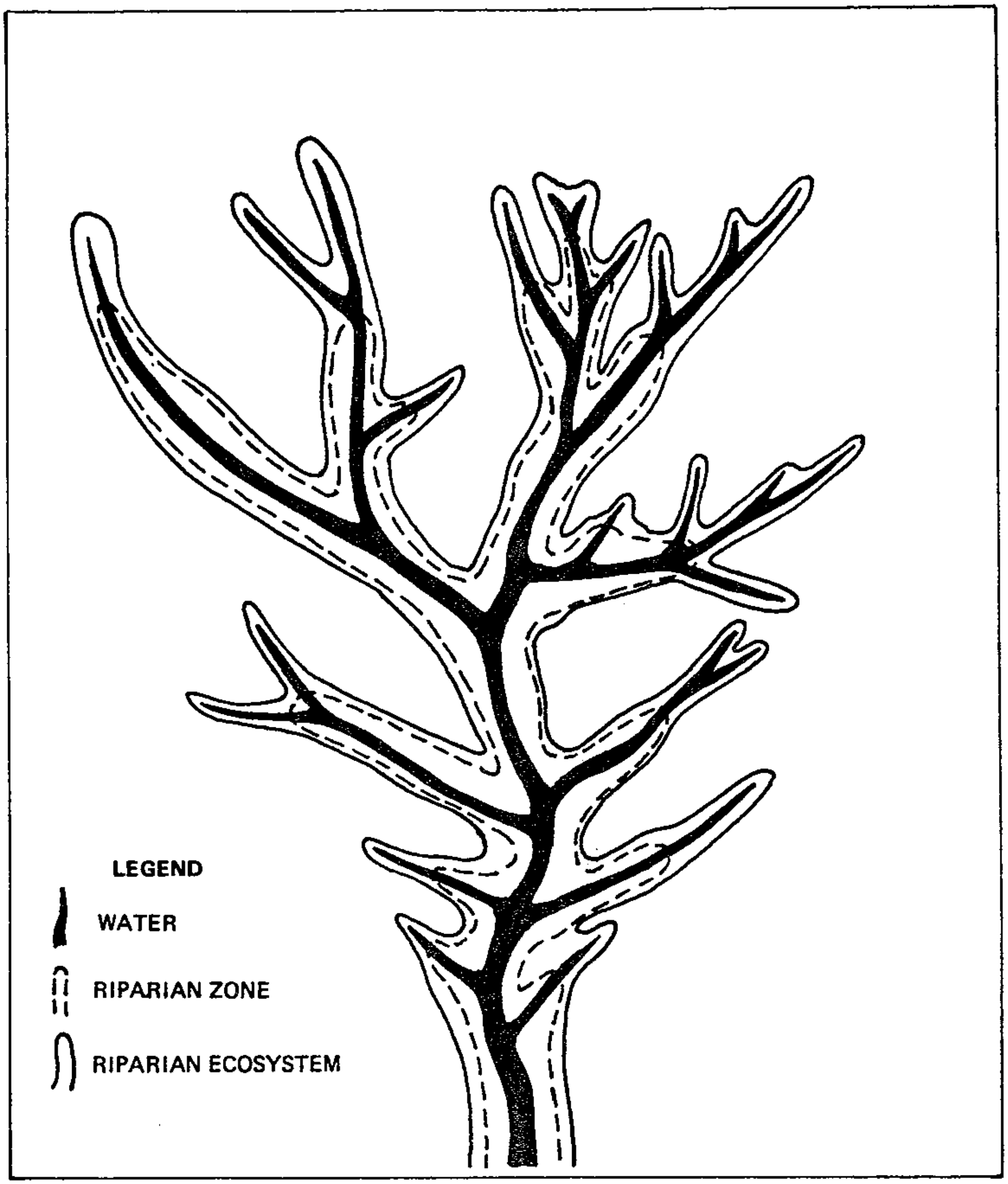


Figure 3. OVERHEAD DIAGRAM OF A RIPARIAN ECOSYSTEM. RIPARIAN ZONES AND ECOSYSTEMS ARE CONTINUOUS NARROW BANDS ALONG STREAMS AND RIVERS. THEY SERVE AS CONNECTORS BETWEEN VARIOUS HABITAT TYPES FOR WILDLIFE. (Adopted from: Thomas, J.W.; Tech. Ed. (18))

AREA INVOLVED IN RIPARIAN ECOSYSTEMS

Accurate measurements of the length of streams, streamside management zones or shorelines throughout the state have not been made. If available, these data would allow estimation of the acreage in riparian areas of fixed width. Because the basic information is unavailable and riparian ecosystems vary in width, we are able to provide only a gross estimate of the area involved in riparian ecosystems (Table 3). We assume that the riparian ecosystems average 200 feet in width on either side of streams (400 feet total). This is based upon the natural height of trees which can provide shade or organic material to a waterbody.

Interim guidelines for riparian management zones have been prepared by the Washington Department of Natural Resources (November, 1984; see Appendix E). These guidelines outline the objectives and methods involved in determining riparian management zones. They provide one example of a program which is being used in Washington's forests lands.

Geppert et al. (6) estimates the total area of riparian management zones at 3-5 percent of the non-federal forest land base. This estimate is derived from limited measurements by Washington Department of Natural Resources staff based upon proposed 100 foot wide riparian management zones on either side of Type 1, 2, and 3 waters. Powell and Loth (7) report a figure of 1.25 percent of non-federal forest lands in Washington as streamside management zones.

Table 3. Estimated Total Area in Riparian Zones and Streamside Management Zones in Washington

Basis for Estimate	% Non-federal Forest Lands*	Total Acres	Source
Riparian Mgmt. Zone; Type 1,2,3 Waters	3-5 %	300,000-500,000	Geppert, (6)
Streamside Mgmt. Zone; Type 1,2,3 Waters	1.25 %	135,000	Powel & Loth,(7)
Riparian Ecosystem; Type 1 - 5 Waters	10 %	1,000,000	

* Percentages are estimated based upon these widths for both sides of the stream types indicated: Riparian management zone = 100 feet; Streamside management zone = 50 and 25 feet; and, Riparian ecosystem = 200 feet. Width of riparian ecosystems is based upon natural height of trees adjacent to streams.

DISTINGUISHING CHARACTERISTICS OF FORESTED RIPARIAN ECOSYSTEMS

Animals interact with the environment to obtain the food, water, cover, and space necessary for survival, growth and perpetuation of their species. Because each body of water has unique physical and biological characteristics, its corresponding riparian ecosystem is also unique. Some features of forested riparian ecosystems which distinguish them from upland habitats are:

a. The presence of surface water during all or part of the year;

b. In general, variable moisture conditions give rise to more complex and diverse vegetation which provide ground, shrub, and canopy habitats in one area;

c. Linear shape, typically a continuous narrow zone of variable width which borders or interconnects with upland habitats;

d. Various edges or "meeting places" between a variety of intermixed plant communities or successional stages (Figure 4);

e. High edge to area ratios which create diversity and richness in habitat types;

f. Microclimates different from surrounding uplands because of topographic location and presence of water. Riparian ecosystems tend to have higher humidity and rates of transpiration with less variation in temperature extremes, (i.e. cooler in summer and warmer in winter) than uplands; and,

g. Recurring disturbance resulting from flooding, erosion and deposition which influences the structure and composition of vegetation.

VARIABILITY IN RIPARIAN ECOSYSTEMS

Conditions in, and sizes of, riparian ecosystems change from one site to another along a stream system and over time at one site. Principal expressions of such changes are: 1) shifts in food and energy production from out-of--stream to instream sources; 2) changes in physical characteristics of stream (e.g. depth, width, gradient); and 3) succession in plant communities over time.

Variability in lakes and lake riparian ecosystems may also be discussed in terms of space and time. With lakes, however, changes are related to physical position within a lake, and time as succession and aging processes occur.

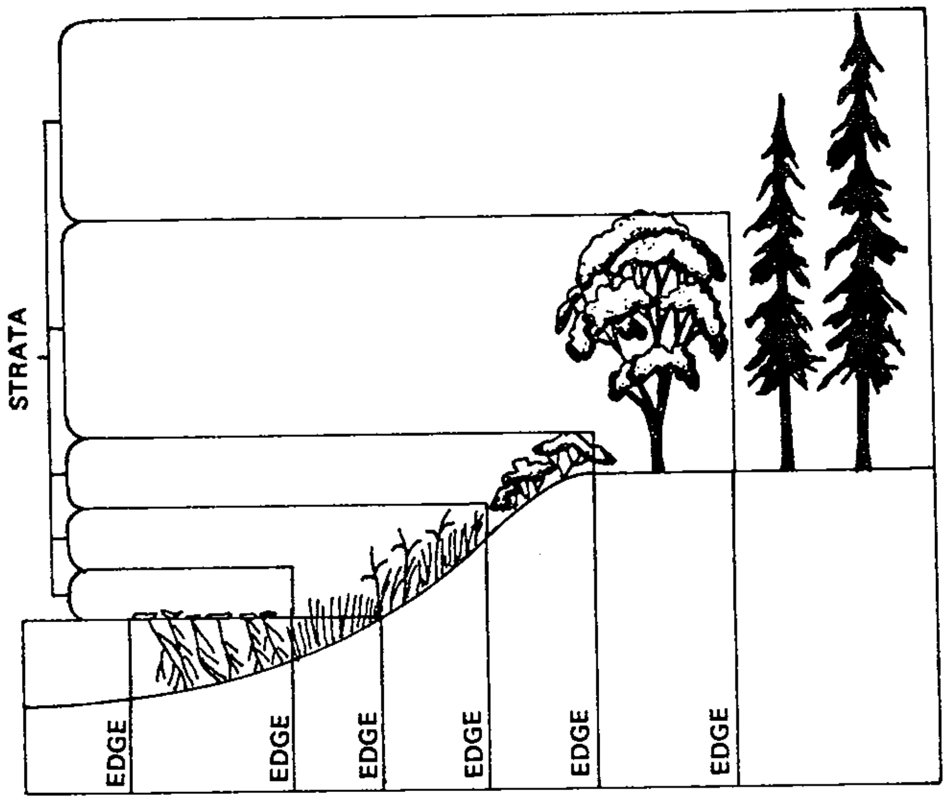


Figure 4. VEGETATIVE EDGES WITHIN A RIPARIAN ECOSYSTEM.

(From: Thomas, J.W.; Tech. Ed. (18))

Spatial Variation

Stream Flow and Gradient

Most physical characteristics of streams are based upon flow (channel capacity) and gradient (channel steepness). Flow is usually described in terms of stream order. A first order stream (Figure 5) is one with no tributaries, a second order streams begins at the confluence of two first order streams, etc. (8). First order streams are generally small low flow streams while fifth order streams and larger are major rivers. While gradient typically moderates as stream order increases, it also may change several times within a stream of a given order.

There are no direct relationships between stream order and water typing as used in the forest practices regulations. We have, however, made the following general comparison of stream order to water type for the purposes of this report.

Table 4. General Comparison of Stream Order to Water Types as Defined by Washington Forest Practices Regulations

Range of Order	Range of Water type
First, second	4,5, some 3
Second, third	3,4 some 2
Third, fourth	3,2,1
Fourth, fifth	1
Sixth, & greater	1

First order streams receive initial runoff or arise from groundwater sources (seeps, springs). Many have only intermittent flow while others receive sufficient ground water input to maintain perrenial flow. The same is true for many second order streams. First and second order streams are typically steep gradient (exceeding 10%) but in many cases woody debris or cobbles are present in the channel which act to stairstep the stream through a series of short riffles or falls. In contrast, however, some first and second order streams are low gradient, arising from springs along valley walls or draining low marshy areas.

Intermediate-sized streams (third, fourth, & some fifth order) are usually perennial and have gradients less than 5% but with falls or steep rapids common. Woody debris is often present, however, it does not exert the same

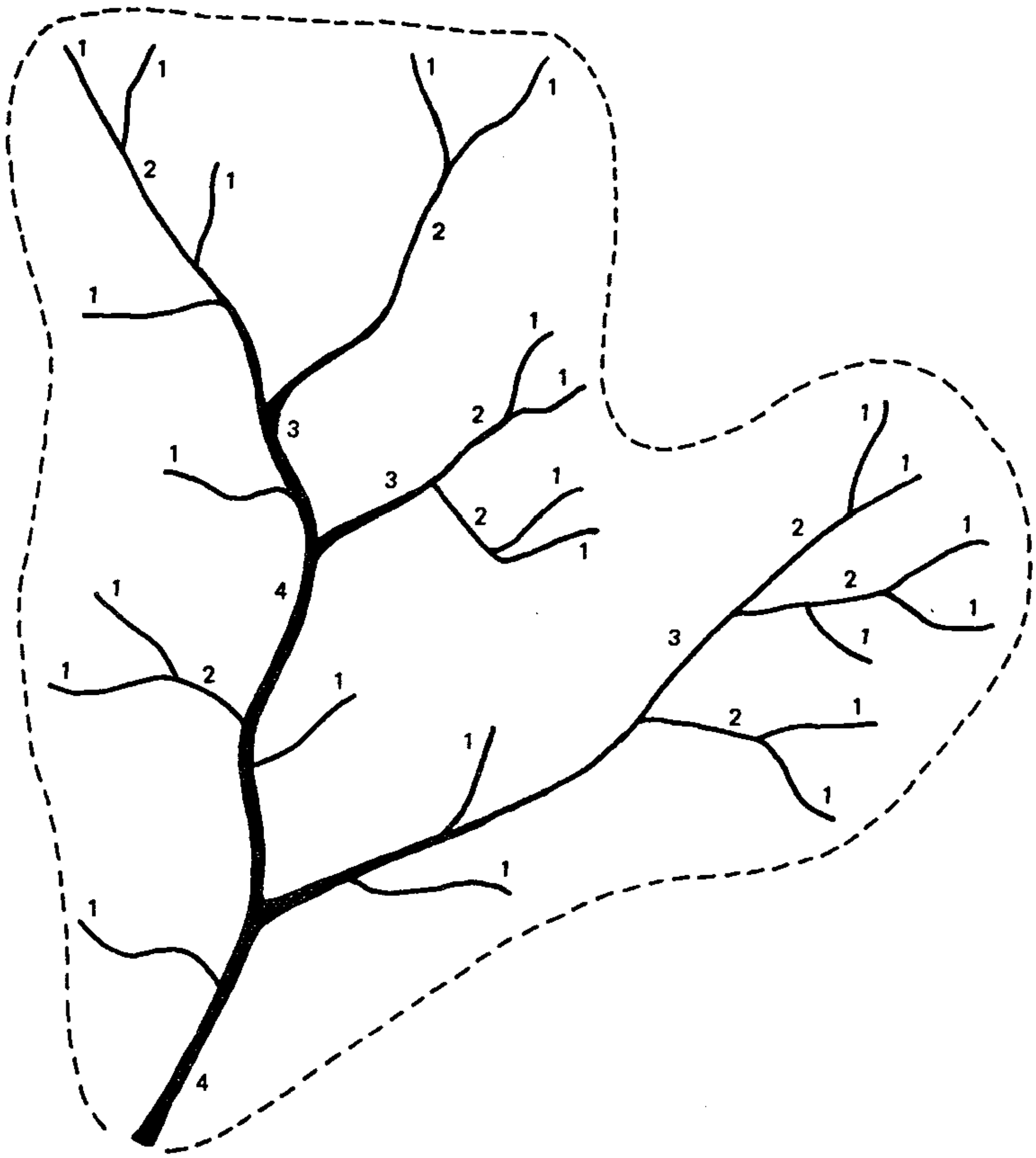


Figure 5. STREAM NETWORK AND STREAM ORDER.
(From: Geppert et al. (6))

influence on stream structure as in smaller streams.

As gradient decreases the stream assumes an alternating series of pools and riffles and associated gravel bars and backwaters. Again, gradient may change several times within streams of this size depending upon the shape of the valley and streamflow.

Large rivers typically continue to reduce in gradient and increase in volume. Though large woody debris occurs less frequently in larger rivers, where it does occur it is often found in accumulations or jams. Such debris accumulations are usually found at bends, where they act to create and protect backwater and side-channel habitats (10). In Washington, as these fifth and larger order streams approach saltwater, many are very slow moving and deep with silt and sand bottoms. Others continue to the sea as swift gravel-bottomed rivers.

The estuary is the transition zone where freshwater meets saltwater. Some estuaries, i.e. within Puget Sound, are very complex with numerous sloughs, backwaters, and tidal flats. Others, e.g. along northern Olympic Peninsula coast, are simple with virtually no estuarial mixing of salt and fresh water. In undisturbed estuaries large woody debris is very prevalent while in developed areas this material is regularly removed for navigational safety.

It is important to view stream systems as a continuum from headwaters to estuaries. Transport of water, sediment and organic debris is interrupted by many complex storage and release processes. Eventually, most material is transported to the mouths of rivers to enter into marine ecosystems.

Within a stream of any order there are also differences in the riparian ecosystem based upon valley geomorphology and climate. Lotspeich (11) stresses that geoclimatic factors develop landscapes that provide the physical basis for ecosystem development. Further, Leopold et al. (12) and Bauer (13) describe stream zones based primarily on channel gradient.

Steep gradient streams are characterized by runoff confined to narrow floodplains. These streams tend to have high velocities that can transport woody debris to downstream areas. Streambed erosion is severe in these areas with boulder and large cobble the predominate substrate. Organic debris is either lacking completely or plays a minor role in forming the channel configuration. However, in areas where canyon walls subside and the floodplain is wide enough, debris accumulations can create and maintain low velocity side channels.

As overall channel gradient moderates to about 5% or less, deposition of fine sediments and gravel is more frequent. In this zone, streams assume a relatively constant ratio of alternating pools and riffles. Riffles in such streams are shallow and steep, and the bottom is composed of varying sizes of gravels which are relatively free of fine sediments. Pools tend to be wider and deeper than the average of the stream course. Current speed in pools drops off and the bottom is composed of small gravel, sand and muck.

Streams of still lower gradient are predominantly slow moving with occasional riffles, but mainly glides and deep pools. Meander patterns are well established. Shorelines may become marshy and backwaters and sloughs appear. The bottom is primarily sands and silts.

Spring-fed sloughs and ponds, often called "wall-based channels", are featured habitats of significant fish use. These streams are found along the lower reaches of many rivers on terraces above the present floodplain. These streams many not follow the typical stream ordering hierarchy. They are most often formed by historical river meander "cutoffs" and gravel-bar deposition during river meander migration (15).

An estuary forms where streams flow into marine waters. The size and form of estuaries varies considerably depending upon the geologic character of the valley, the stream gradient and volume, and the geology of the marine shoreline. In Washington some estuaries such as the Snohomish river mouth are very complex with numerous sloughs, shallow bays and extensive tidal flats. Others, such as the Quinault River are simple, entering directly into the ocean with limited area for mixing of salt and freshwater.

Spatial Variation - Streams

Out-of-stream versus Instream Production

Interactions between riparian vegetation and aquatic ecosystems change systematically with variation in stream size (14, 4, 15). Small headwater streams are largely dependent upon input of organic litter from adjacent plants for energy supplies (14). This is particularly the case where penetration of sunlight is minimal because of canopy closure or from topographic shading.

As a stream increases in size and width it can begin to develop a floodplain and have a greater expression of understory plants. Instream production by primary producers (algae and vascular plants) occurs as sunlight penetrates to the water surface when stream canopies are more open (15).

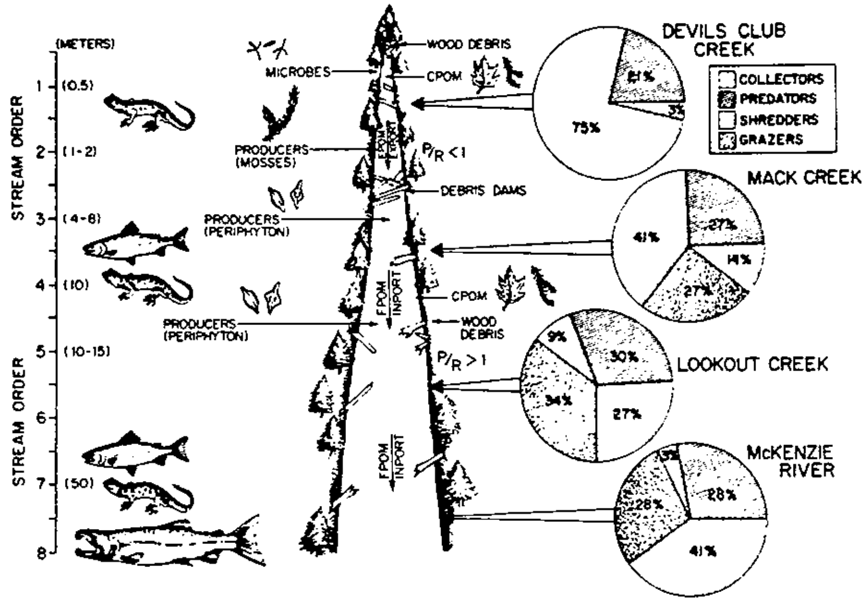


Figure 6. Stream Size and Sources of Energy for Aquatic Production (from Triska, F.J., J.R. Sedell, and S.V. Gregory; Coniferous Forest Streams. U.S.D.A. Forest Service, 1982)

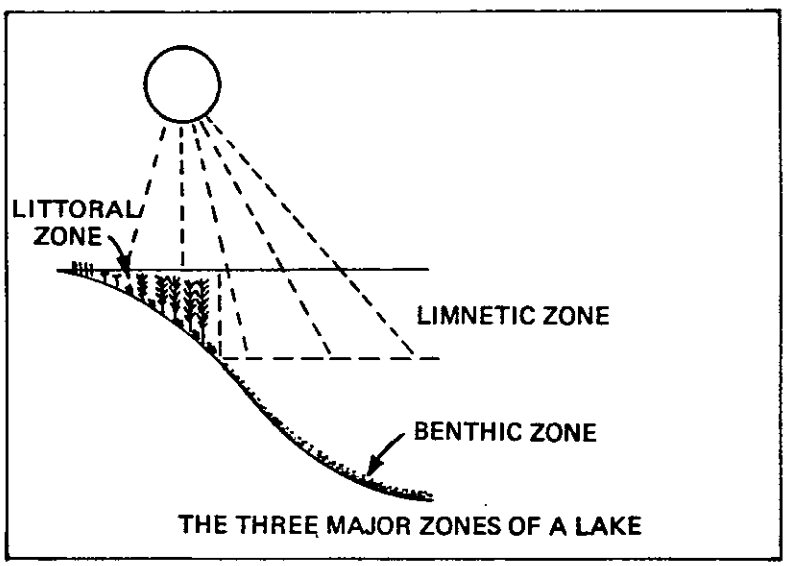


Figure 7. ZONES WITHIN LAKES. (After Odum, E.P. (20))

Larger streams and rivers such as the Deschutes, Methow or Skagit typically have well developed flood plains with well developed riparian plant communities. Water surfaces are exposed to sunlight, therefore, the shift from reliance on out-of-stream sources of litter for aquatic energy to instream sources is predominant. Swanson et al. (15) note that for streams in western Oregon the shift in sources of energy occurs in larger third and fourth order streams (Figure 6).

Spatial Variation - Lakes

Lakes can also be divided into physical zones that have corresponding levels of abundance and diversity of fish species (16). The zones are the littoral, limnetic, and benthic (Figure 7).

In a lake the littoral zone is the band from shoreline to the depth where rooted aquatic plants are absent or where bottom algae growth ceases. This zone is very important as the spawning and rearing region of typical lake fishes. The limnetic zone is the lakeward open water beyond the littoral zone. The benthic zone is defined as the lake bottom.

In terms of the riparian ecosystem, the littoral zone is of most concern. This is because conditions in this zone are most subject to alteration by forest practices along and near shorelines.

Fish rearing capacity in lakes is directly influenced by the relationship of one zone to another (e.g. extent of shallow littoral zone to extent of shoreline), the presence of inflow or outflow, and ground water upwelling along beaches. Fish populations in many Washington lakes are dependent upon streams for spawning, however, in some lakes such as Lake Washington, groundwater upwelling through beach gravels is utilized for spawning.

Temporal Variation - Vegetation

Forest Succession

Succession implies an orderly, progressive replacement of one plant community by another over time. Given no major disturbances the process of succession is gradual, continuous and predictable (19).

We employ the concept of succession in this report, particularly as it relates to the direct influence zone, as a method of relating plant community development to fish and wildlife habitat. Succession is a concept familiar to foresters and forest resource managers. It allows approximation of a key feature in understanding wildlife habitat - the species composition, structure, and age of plant communities.

The successional development of vegetation in riparian ecosystems in the Pacific

Northwest follows theories of secondary forest succession introduced by Clements (17). According to this theory, disturbance in the forest creates an unvegetated substrate followed by recolonization by intolerant pioneer species. These species are subsequently replaced by other more tolerant species in a predictable series of vegetative changes leading to an old growth or climax condition; given the assumption that catastrophic environmental disturbances do not interfere.

Our treatment of forest succession follows that of Thomas, et al. (18) when plant growth progresses from grass-forb through old growth coniferous forest (Figure 8). No age classes are assigned to the six idealized stages because of the variable growing conditions throughout the state.

Given indefinite time with no disturbance to the site, vegetative succession in uplands would eventually, (approximately 750 years), result in a climax old growth forest with intolerant Douglas-fir being replaced by more shade tolerant western red cedar, western hemlock, and true firs. In theory, this is a mature, stable, self-sustaining, and self-reproducing plant community. Such stability was seldom attained in Pacific Northwest forests because of natural disturbance. Secondary succession, initiated by catastrophic wildfire, floods, windthrow, and insect and disease created a mosaic of forest stands and age classes that species of fish and wildlife have evolved under.

The frequent disturbances and the wet site conditions of riparian zones give rise to plant communities somewhat different in composition and structure from uplands (Table 5). Succession is interrupted with sufficient frequency that permanent immaturity may be a prime characteristic of riparian zones (20).

Vegetative composition and habitat conditions of riparian areas are influenced by natural stream processes of erosion and deposition, topography, substrate, and stream gradient. The adjacent, upland forest (i.e. direct influence zone) can also affect the extent and composition riparian plant communities through shade and competition (20).

In mature forests, canopy closure often occurs over first order streams. Typical riparian plant communities are, therefore, suppressed. Second and third order streams are often large enough to create openings in the overstory where penetration of sunlight stimulates growth of more typical riparian plants.

Successional development in both west and eastside riparian ecosystems has been altered since the development period started over one hundred years ago. Clearing of overstory trees, protection from natural fire, intense grazing, splash damming and stream cleanout, and urban development have modified stream courses and reverted succession to early stages such as shrubs, hardwoods, and pole/sapling timber.

Temporal Variation - Lakes

Lakes also exhibit habitat variability over time. Generally, this is related to their productivity, but can be related to an aging process. Oligotrophic lakes are most often deep, cold and low in nutrients and plant populations. Accordingly, these lakes are typically inhabited by the coldwater fishes such as salmon and trout.

Lakes of this type may undergo ecological succession into the eutrophic type. Such succession or eutrophication occurs very slowly or not at all in some environments or very quickly depending upon the rate of filling by organic and inorganic material and productivity of streams and uplands adjacent to the lake.

Eutrophic lakes tend to be shallower, warmer, and occupied by larger and more numerous aquatic plants such as pond lillies and milfoil. Cold water species are replaced by temperature tolerant fishes such as bass, perch, and crappie. As aging progresses a eutrophic lake gradually fills, the water becomes even more shallow and warm, and because of their highly organic nature they become acidic and low in productivity and biological activity. In Washington these lakes or bogs and marshes may be inhabited by mudminnow.

FIGURE 8. IDEALIZED STAGES OF FOREST SUCCESSION

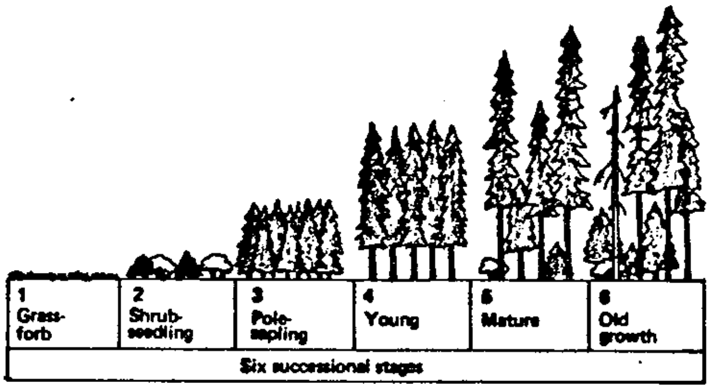


Figure 8. IDEALIZED STAGES OF FOREST SUCCESSION.
(From: Thomas, J.W.; Tech. Ed. (18))

Table 5. Riparian Plant Communities

Herbaceous Dominated	-	Bogs, marshes, meadows dominated by herbaceous plants with minimal shrub cover (less than 60%) when associated with lakes, streams,or other waterbodies. Climax successional stage. Includes grass and sedge meadows, tule marshes, and alpine-subalpine meadow plant communities.
Hardwood Dominated	-	Hardwood and shrubby wetland or swamp of black cottonwood, alder, bigleaf maple. Often with a shrubby component of willow, hawthorn, etc. associated with standing or flowing water. Successional stages apply. Includes alder-hardwood bottomlands, Oregon oakwoods, and quaking aspen plant communities.
Coniferous Dominated	-	Coniferous forest with standing or flowing water part of the season or longer with a high water table in a riparian setting. Often consists of red cedar and western hemlock closest to water with Douglas fir on upper banks and benches. Includes Sitka spruce-cedar-hemlock, cedar-hemlock-Douglas fir, silver fir-Douglas fir, subalpine fir-mountain hemlock, subalpine fir-Englemann spruce, ponderosa pine, interior Douglas fir, grand fir-Douglas fir, and lodgepole pine plant communities.

[Adopted from: Brown, R. (22); Chapter 2, Forest Habitat Relationships Project, Figure 1]

CHAPTER 3

HABITAT REQUIREMENTS, SPECIAL HABITAT CONDITIONS AND SPECIES DIVERSITY

Thomas et al. (18) state that wildlife use riparian zones disproportionately more than any other type of habitat in the Blue Mountains of Oregon and Washington. Similarly, Brown et al. (22) indicate that riparian zones and wetlands are among the most heavily used habitats of forested areas in western Oregon and Washington.

GENERAL HABITAT REQUIREMENTS FOR WILDLIFE

The density, diversity, and structure of vegetation in combination with the topography in the riparian ecosystem provides more habitat niches for wildlife to meet their life's needs than any other type of habitat. Wildlife can find food, water, cover, and space all in close juxtaposition within the riparian ecosystem.

The habitat elements which supply the needs of wildlife are described in the following sections. The table following these sections (Table 6) provides examples of animals which use various habitat niches in riparian ecosystems.

Food and Water

Most wildlife satisfy their need for water by drinking rather than receiving it through their food. Since water is an integral part of the riparian ecosystem for all or a portion of the year, animals tend to seek out and concentrate in this habitat.

In addition, water, the ground cover layer, shrub layer, tree layer, and dead and down tree (snag) components all supply a forage substrate for different groups of animals. Since soil productivity is usually greater in riparian habitats than upland, the diversity and density of each of the vegetative layers is greater.

Foods for foliage, seed, berry, and nut eaters can be found in greater abundance and variety in riparian ecosystems than in uplands. Insects find habitat in foliage, dense litter, dead and down wood, and in the aquatic system of riparian areas, therefore insects eating wildlife are attracted to these areas.

The moist, mild microclimate provides a greater abundance of mushrooms and other fungi than elsewhere, which are food for many small mammals. The aquatic system itself supports wildlife that feed on fish, crayfish, snails, amphibians, and other aquatic organisms. In turn predators are attracted by the abundance of prey species in riparian habitats.

Areas to Breed and Rear Young

The diversity of habitat niches described above also provides areas for breeding and rearing young. Many animals seek areas near water with both food and cover nearby; deer and elk seek such areas for fawning and calving; most amphibians require such areas for both breeding and rearing.

The ground cover, shrub and tree layers are each used by numerous ducks, large birds of prey, wading birds, shore-birds, and songbirds for nesting and rearing. The water itself, down wood and snags are also important rearing habitats.

Areas to Hide and Rest

The dense vegetation, topography, and water found in riparian ecosystems provide areas in which animals can hide or rest in security. Dense foliage, hollow trees, down wood, burrows and dens are required by many kinds of wildlife.

Several aquatic mammals hide and rest in dens or lodges in the water. Amphibians and reptiles rest on floating vegetation or logs and often hide in the water. Many small mammals burrow into or create runways through the dense ground cover layer, while hares and some birds use shrubs. Trees are used by squirrels, large birds of prey and many other kinds of animals.

Areas to Escape Severe Weather

The topography, presence of water, and the density and diversity of vegetation in the riparian ecosystem strongly influence its climate. Extreme temperatures upland are generally moderated within riparian habitat. These areas are often cooler in summer and warmer in winter, and so are often sought out as thermal cover during extreme weather.

In summer, when temperatures are high and humidity is low, these areas provide both a cooler and moister environment than surrounding areas. Some owls are known to move upslope and downslope during the day in hot weather in response to these factors, deer often take cover under shrubbery, and Roosevelt elk are often observed standing in water under a tree canopy to shed heat.

In severe winters, temperatures are often moderated in riparian ecosystems, and because of elevational position, are freer of snow than uplands. Larger mammals, in particular, concentrate in these areas where conifers dominate.

Areas for Travel

Riparian habitats are often sought as travel corridors to and from summer and winter ranges by large mammals, many furbearers, and predators. Because of the moderating influence of the vegetation and water on temperatures these zones are available for travel later in the fall and earlier in the spring than upland areas. Many other kinds of animals use riparian ecosystems to travel between feeding, breeding, rearing, hiding, and resting habitats within their home ranges.

Table 6. Examples of Animals Which Use Riparian Habitat Niches

	Feeding	Reproduction	Cover	Travel
Aquatic	kingfisher otter osprey	muskrat beaver duck	beaver muskrat frog	beaver otter dipper
Ground Cover	deer mouse rabbit deer	duck shorebird grouse	frog turtle vole	shrew vole garter snake
Shrub	elk sparrow grouse	sparrow wren hare	hare deer goose	flycatcher sparrow wren
Tree	chickadee beaver squirrel	eagle heron squirrel	elk eagle fisher	mink flying squirrel elk
Snags	woodpecker creeper black bear	woodduck marten osprey	marten raccoon squirrel	

GENERAL HABITAT REQUIREMENTS FOR FISH

Life cycle requirements for fish include:

- sufficient water quantity and moderate flow regime
- waters that permit fish passage
- waters with substrate and cover for reproduction
- water with riparian and instream cover
- waters with adequate food supply.

Good Water Quality

Water must be of sufficient quality to sustain normal life functions of fish. Good water quality can be defined as desired or tolerable levels of temperature, suspended/settleable sediment concentrations, and basic water chemistry (e.g. acidity, salinity, dissolved oxygen, nutrients, etc.). Anadromous fish and cold water game fish require cool to moderate water temperatures without sudden, extreme fluctuations. Warm water game fish require warmer temperatures than salmonids for reproduction (Table 7).

TABLE 7. LOWER, PREFERRED, AND UPPER TEMPERATURE RANGES FOR VARIOUS FISHES

Species	Lower Temperature Range	Preferred Temperature Range	Upper Lethal Temperature
	....	Degrees Fahrenheit	....
Chinook	>32	45.1 - 58.3	77.4
Coho	>32	53.2 - 58.3	78.4
Chum	>32	52.2 - 58.3	78.4
Pink	>32	42.1 - 58.3	78.4
Sockeye	>32	52.2 - 58.3	76.3
Steelhead	>32	45.1 - 58.3	75.4
Cutthroat	>32	49.1 - 55.2	73.4
Bluegill Sunfish	36	60 - 80	94
Small Mouth Bass	41	68 - 71	85
Yellow Perch	34	54 - 70	85
Sucker	-	53 - 71	86

[Source: Bell, (23)]

Water clarity influences light penetration and the ability of sight feeding fish to obtain food. Suspended sediment blocks the transmission of light and reduces the depth at which photosynthesis can occur. A reduction of primary productivity by algae and vascular plants may reduce the insect populations in a stream (24). Turbid waters can inhibit salmonid feeding. Noggle (25) found that coho salmon could no longer perceive their prey organisms when suspended sediment levels reached 400 parts per million. These fish had been acclimated to background levels near zero suspended sediment loads.

High levels of suspended sediment can have multiple effects on fish, including damage to gill tissues, reduced disease tolerance, direct mortality, as well as increased ability of small fish to avoid predation.

High levels of dissolved oxygen (greater than 5 parts per million) are required for the majority of fish species (28, 29). The dissolved oxygen requirement for survival of salmon eggs is higher (8ppm) then drops to a lower level (5 ppm) after hatching (29).

Water quality characteristics are interrelated, so a change of one characteristic which is deleterious to fish frequently means that other problems exist. For instance, dissolved oxygen concentration is temperature dependent. Where fish are stressed by high water temperature the stresses are likely compounded by low dissolved oxygen concentration.

Sufficient Water Quantity and Moderate Flow Regime

Water must be present in sufficient quantities to meet life stage (egg, juvenile, adult) requirements of fish. Water depth and flow determine the "living space" of fish, as well as influence water quality characteristics such as temperature and dissolved oxygen. Fish biomass (the total weight of fish in a given area at a point in time) has been related to living space. Fish species often exhibit territorial behavior which is related to food abundance and living space.

Water depth further serves as part of the cover requirements of fish. Turbulent flow can create cover which discourages predation by birds, mammals, and other fish.

Native anadromous runs of salmonids have adapted to the particular flow variability of their parent streams. Significant departures in either high or low flows can affect the migration and spawning success of such runs.

Waters That Permit Fish Passage

Fish must be able to move within and between water bodies. Physical obstructions which prevent or discourage migration can take the form of culverts, dams, log jams, debris dams, mud slides, etc.. Hydraulic obstructions are velocity and depth barriers, (i.e. shallow water).

General guidelines for road culvert design indicate that velocities should not exceed 4 feet per second (fps) for adult trout and 8 fps for adult salmon and steelhead (32). These guidelines are for runs less than 100 feet in length. For longer runs, the guidelines drop to 3 and 6 fps, respectively. For passage of juvenile salmonids culvert velocities should generally not exceed 1.0 fps (30).

As upstream migrants, adult salmon and steelhead require a portion of the stream cross-section to have sufficient depth so passage will not be impeded. Minimum depths of 10 inches for chinook and 7 inches for coho and steelhead are recommended passage conditions (29). Juvenile salmonids may require access to upstream areas either for summer or winter distribution.

Barriers to adults can also result from water that is too warm with associated oxygen depletion. Further, excessive turbidity may act as a barrier movement of adult fish.

Waters with Substrate and Cover for Reproduction

Water depth and velocity must be adequate for spawning to occur. Substrate (e.g. rocks, gravel, aquatic plants) are required in sufficient quantity and quality to meet reproductive behavior needs of fish.

Salmon and trout must have gravel for spawning. Gravel should range between 0.2 inches and 6 inches in diameter with larger fish using the larger sizes. Extremes in sizes, either smallest or largest are least desirable. Gravel deposits of from 6 to 16 inches in depth are the minimum necessary to allow construction of redds, with the deeper deposits used by larger salmon.

Usable salmonid spawning gravel must be relatively free of sand and silt and must not be compacted. Excessive levels of sand and silt create adverse conditions for eggs and fry by causing low intergravel water flows which in turn result in decreased supplies of dissolved oxygen. Large amounts of fine material can also reduce survival of fry because they fill the gravel interstices and block the fry emergence route out of the spawning bed (29).

Substrate and cover utilization by spiny-ray fish are discussed below (29):

a. Yellow perch deposit strings of eggs on submerged branches, clean rocks, and underwater plant stems.

b. Male members of the sunfish family (basses, crappie, and bluegill) all dig cup-shaped redds. Redds are usually in shallow water, less than 6 feet in depth, on a hard surface such as hardpan, rocks, gravel, or root masses. Largemouth bass often make redds on stumps or logs.

c. Catfish and bullheads spawn inside such things as holes, hollow logs, tiles, burrows, and old tires.

<u>Waters with Riparian and Instream Cover</u>

Overhanging terrestrial vegetation, aquatic vegetation, undercut banks, submerged objects such as logs and rocks, floating debris and water depth and turbulence are paramount to fish survival. A good mix of cover types is required for resting, feeding, and hiding.

Excessive levels of silt and debris can fill in hiding and resting cover around rocks and logs. Unstable sands and gravel can also impact hiding and resting cover.

<u>Waters That Have Adequate Food</u>

In general, fish are opportunists that feed on plankton, terrestrial, and aquatic invertebrates, other fish, and even small mammals and birds. Terrestrial and aquatic invertebrates represent very important fish food in Pacific Northwest streams and lakes.

Terrestrial insects enter water by flying in, falling, or being blown off riparian vegetation and by being washed in from the shoreline or wave action. Terrestrial insects must be readily exploitable by fish in order to be important in the diets of fish. This means that they must have their food requirements met by adequate vegetation growth. It also means that the insects, their food sources, and their resting areas must be close to water so that the insects can enter water, becoming potential prey for fish.

FISH AND WILDLIFE SPECIES DIVERSITY IN RIPARIAN ECOSYSTEMS

<u>Fish Species Found In Washington</u>

Wydoski and Whitney (33) list 77 species of fish which inhabit freshwater in Washington for all or a portion of their lives (Appendix B). They include members of 19 different taxonomic families; notably salmonidae (salmon, trout and charr), cyprinidae (minnows and carps), catostomidae (suckers), centrarchidae (sunfish and bass), acipenseridae (sturgeons), and cottidae (sculpins).

The salmonids are featured in the following discussions because generally they are the fish most likely to occur in forested watersheds. The other species, while important in their own right, are usually not affected by forest practices. For those that are, it is assumed that, if habitat requirements for salmonids are met, their needs will also be met.

Orientation of Fish Species To Stream Order and Gradient

Salmonid fish have, through a long process of adaptive evolution, become fitted to their environment through certain characteristics of their body size, shape, and physiology (34). Habitat utilization by a particular species may vary with competition for food or cover among or between species (35). Further, fish populations are often physically isolated. For example, sea-run and resident cutthroat trout populations are often isolated from one another by migratory blocks such as cascades or falls (36).

Different species or races may also be isolated in time or space because of different life history patterns. Chum salmon, for example, typically spawn in the lower reaches of a stream and their young migrate directly to sea upon emerging from the streambed. Coho salmon on the other hand typically spawn in the upper stream reaches and their offspring distribute themselves throughout the entire stream for a freshwater residence of 12 to 15 months. In another case, chinook salmon will utilize large tributaries and mainstem river habitats for spawning. Sea-run cutthroat will spawn even further upstream in the headwater tributaries. Within a given stream reach various fish species may co-exist provided the habitat is diverse enough to provide spatial segregation. For instance, coho salmon, cutthroat trout and steelhead trout may utilize the same stream reach (37), but occupy different niches. Underyearling coho salmon usually prefer pool habitats and avoid riffles, whereas steelhead juveniles show a strong preference for riffles and other fast water habitats. Underyearling cutthroat trout generally prefer low gradient riffles, however, in the anadromous zone they are often displaced by competition from steelhead and coho. Older cutthroat generally prefer pools but also may not be present with coho in an anadromous zone. Cover in the form of depth, shade, woody debris, rock rubble, etc., has been demonstrated to be of great importance in determining species numbers and diversity (38).

Habitat utilization by various species is also related to stream order and gradient (22, 33). Generally, as stream order increases fish utilization increases. Correspondingly, as gradient decreases numbers of fish and fish species increase. For example, first and second order streams may contain cutthroat trout (resident and/or anadromous) and adult coho and steelhead spawners. Third and fourth order streams are additionally inhabited by chinook, chum and pink salmon, and fifth order streams are inhabited by all species with cutthroat occuring in lesser numbers. During the rearing and migratory stages there is considerable overlap of all species in the higher stream orders.

Habitat utilization may vary over time. Bustard & Narver, (40) demonstrated a shift in habitat use by coho and steelhead during the winter months. Their observations revealed that as water temperature dropped coho and steelhead moved to deeper water; juvenile fish fed less and moved to areas of low velocity and cover. Steelhead fry were often found under streambed rubble (4-6 in. rock). Coho and older steelhead were most often observed under logs or within submerged rootwads. They also found cutthroat and steelhead trout and coho salmon moving into smaller tributaries in the late fall.

Coho salmon in the Clearwater River on the Olympic Peninsula were shown to migrate several miles from the upper river during the fall to small ponds and side tributaries connected to the main river (41, 42). This phenomenon has been observed in various other streams in Washington. In the Cowlitz River an off -channel pond with no spawnable tributaries and seasonal outlet (October to May) was observed to have coho salmon under-yearlings migrating into it during November and December with rising streamflow.

Wildlife Species Found in Washington

Approximately 480 species of vertebrate wildlife inhabit terrestrial and aquatic habitats throughout Washington. At least 291 (60 percent) are found in forest riparian ecosystems. This group includes at least 74 mammals, 179 birds, and 38 species of reptiles and amphibians.

The Wildlife Sub-committee opted to use four categories to illustrate the use that each wildlife species makes of riparian ecosystems. These use catagories were developed without assignment of specific wildlife-vegetation relationships. They include species which orient to one or more of the successional stages or plant communities previously discussed.

The first category (Table 8) includes animals which require riparian ecosystems to satisfy a vital habitat need during all or part of the year. Where large areas of riparian habitat are modified so that vital needs are no longer met, these species are eliminated. Wildlife in this category range from species which spend their entire lives in riparian habitats to those whose food supply, cover needs, or reproductive requirements are found only there. Some species rely on these habitats only seasonally, while others are year-round residents.

Species in this category include 12 mammals (16 percent of all mammals which use riparian habitats). These mammals range from a big game species to several furbearers to tiny shrews and a bat. There are 42 birds in this category (24 percent of those which use riparian habitat), these include many ducks, shorebirds, fish-eating birds, marsh birds, and some large birds of prey. The northern bald eagle, Federally -listed as a Threatened Species, requires riparian ecosystems to provide a vital habitat need. At least 14 reptile and amphibian species are in this category (37 percent of those which use the riparian ecosystem). Included are several salamanders and frogs, turtles, and a snake. The western pond turtle, which is State-listed as Threatened, is dependent for survival on the riparian ecosystem.

TABLE 8. ANIMALS WHICH REQUIRE RIPARIAN ECOSYSTEMS TO SATISFY A VITAL HABITAT NEED DURING ALL OR PART OF THE YEAR

Mammals

Mule Deer	Northern Bog Lemming (SC)
River Otter	Yuma Myotis
Mink	Preble's Shrew
Beaver	Dusky Shrew
Muskrat	Pacific Water Shrew
Nutria	Water Shrew

Birds

Great Blue Heron	Osprey
Great Egret (SC)	Virginia Rail
Snowy Egret	Sora
Black-crowned Night Heron	Semipalmated Plover
Green Heron	Solitary Sandpiper
American Bittern	Greater Yellowlegs
Mallard	Spotted Sandpiper
Gadwall	Long-billed Dowitcher
Pintail	Lesser Yellowlegs
Green-winged Teal	Willet
Blue-winged Teal	Least Sandpiper
Cinnamon Teal	Western Sandpiper
American Wigeon	American Avocet
Shovler	Band-tailed Pigeon
Harlequin Duck	Bank Swallow
Hooded Merganser	Belted Kingfisher
Wood Duck	Dipper
Common Goldeneye	Northern Waterthrush
Barrow's Goldeneye	Yellowthroat
Bufflehead	Yellow-headed Blackbird
Bald Eagle (FT)	Red-winged Blackbird

Reptiles and Amphibians

Rough-skinned Newt	Green Frog
Cope's Salamander	Leopard Frog
Olympic Salamander	Spotted Frog
Pacific Giant Salamander	Tailed Frog
Northwestern Salamander	Western Pond Turtle (ST)
Cascade's Frog	Painted Turtle
Bullfrog	Common Gartersnake

(FT) = Federally-listed; Threatened (ST) = State-listed; Threatened (SC) = Species of Concern; State-listed proposed Threatened or Endangered, Sensitive and proposed Sensitive (31).

The second category (Table 9) includes animals which, based upon professional judgement may be found in other habitats, but are most numerous in, or more heavily use, riparian ecosystems. Abundance is a key feature of this category. Although these species may be found in other habitats, more individuals of each species use riparian ecosystems or spend more time there than elsewhere.

There are 39 mammals (53 percent) which prefer or are more successful in riparian habitats. They include most big game animals, small game, several furbearers, rabbits, and many small mammals and bats. The Columbian white-tailed deer, a Federally-listed Endangered species, uses riparian ecosystems more heavily than other habitats. There are 49 birds in this category (27 percent of all those which use riparian habitats). These cover the full range of birds including hawks, owls, flycatchers, warblers, and many other songbirds. The peregrine falcon, which is a Federally-listed Endangered species, and the sandhill crane, a State-listed Endangered species, are both in this category. There are 16 reptiles and amphibians (42 percent) in this category. These include salamanders and frogs, but also toads and most snakes are more abundant in riparian ecosystems or use them more heavily.

TABLE 9. ANIMALS WHICH MAY BE FOUND IN OTHER HABITATS BUT ARE MOST NUMEROUS IN, OR MORE HEAVILY USE, RIPARIAN ECOSYSTEMS

Mammals

White-tailed Deer
Columbian White-tailed Deer (FE)
Moose
Roosevelt Elk
Rocky Mountain Elk
Vagrant Shrew
Black Bear
Bobcat
Opossum
Shrew-mole
Keen's Myotis
Long-eared Myotis
Long-legged Myotis (SC)
California Myotis
Small-footed Myotis
Silver-haired Bat
Western Pipistrel
Big Brown Bat
Hoary Bat
Pallid Bat (SC)
Eastern Cottontail
Nuttall's Cottontail
Mountain Beaver
Least Chipmunk
Yellow-pine Chipmunk
Meadow Vole
Montane Vole
Townsend's Vole
Long-tailed Vole
Water Vole
Western Jumping Mouse
Pacific Jumping Mouse
Red Fox
Raccoon
Fisher (SC)
Ermine
Long-tailed Weasel
Western Spotted Skunk
Striped Skunk

TABLE 9 (CON'T.) ANIMALS WHICH MAY BE FOUND IN OTHER HABITATS BUT ARE MOST NUMEROUS IN, OR MORE HEAVILY USE RIPARIAN ECOSYSTEMS

Birds

Goshawk (SC)	Common Merganser
Sharp-shinned Hawk	Common Snipe
Cooper's Hawk	Yellow Warbler
Peregrine Falcon (FE)	Wilson's Warbler
Ruffed Grouse	Yellow-rumped Warbler
California Quail	MacGillivray's Warbler
Mountain Quail	Northern Oriole
Black Tern	Western Tanager
Downy Woodpecker	Lalzuli Bunting
Yellow-bellied Sapsucker	American Goldfinch
Eastern Kingbird	Rufous-sided Towhee
Western Kingbird	Tree Sparrow
Dusky Flycatcher	Song Sparrow
Western Flycatcher	Lincoln Sparrow
Long-billed Marsh Wren	Vaux's Swift
Warbling Vireo	White-throated Swift
Willow Flycatcher	Violet-green Swallow
Veery	Tree Swallow
Red-eyed Vireo	Rough-winged Swallow
Yellow-breasted Chat	Barn Swallow
Long-eared Owl	Cliff Swallow
Barred Owl (SC)	Sandhill Crane (SE)
Black-chinned Hummingbird	Purple Martin (SC)
Black-capped Chickadee	House Wren
Black-headed Grosbeak	

Reptiles and Amphibians

Long-toed Salamander	Great Basin Spadefoot
Tiger Salamander	Pacific Treefrog
Ensatina	Red-legged Frog
Dunn's Salamander (SC)	Rubber Boa
Van Dyke's Salamander	Western Gartersnake
Western Red-backed Salamander	Northwestern Gartersnake
Western Toad	Western Rattlesnake
Woodhouse's Toad	Sharp-tailed Snake

(FE) = Federally-listed; Endangered
(SE) = State-listed; Endangered
(SC) = Species of Concern; State-listed, proposed Threatened or Endangered, Sensitive, or proposed sensitive (31).

The third category (Table 10) includes animals which are found at about the same level of abundance in riparian ecosystems as other habitats. Here, also, professional judgement is used in placing species in this category. Since animals in this category are found with the same abundance within and outside riparian habitats, the significance of the riparian ecosystem depends upon the relative proportion it comprises of the total habitat available in an area.

There are 23 mammals in this category (31 percent of the mammals which use riparian ecosystems). These include a number of large and small predators, a big game species, several squirrels, and other small mammals. The 66 birds (37 percent) include several hawks and owls, some upland game birds, hummingbirds, some woodpeckers, as well as numerous songbirds. The ferruginous hawk of eastern Washington and the spotted owl of central and western Washington are in this category and have been listed by the State as Threatened species. There are only 8 reptiles and amphibians (21 percent) in this category; they are limited to reptiles and include lizards and snakes.

TABLE 10. ANIMALS WHICH ARE FOUND IN RIPARIAN ECOSYSTEMS AT ABOUT THE SAME LEVEL AS OTHER HABITATS

Mammals

Coyote
Black-tailed Deer
Wolverine (SC)
Badger
Mountain Lion
Lynx
Porcupine
Marten (SC)
Douglas Squirrel
Red Squirrel
Western Gray Squirrel (SC)
Northern Flying Squirrel
Northern Pocket Gopher
Bushy-tailed Woodrat
Deer Mouse
Southern Red-backed Vole
Heather Vole
Creeping Vole
Masked Shrew
Trowbridge's Shrew
Pygmy Shrew
Townsend's Big-eared Bat (SC)
Snowshoe Hare

Birds

Turkey Vulture
Red-tailed Hawk
Swainson's Hawk (SC)
Rough-legged Hawk
Ferruginous Hawk (ST)
Marsh Hawk
Golden Eagle (SC)
Gyrfalcon (SC)
Merlin (SC)
American Kestrel
Blue Grouse
Spruce Grouse
Turkey
Killdeer
Mourning Dove
Barn Owl
Screech Owl
Great Horned Owl
Pygmy Owl
Great Gray Owl (SC)
Saw-whet Owl
Spotted Owl (ST)
Common Nighthawk
Rufous Hummingbird
Calliope Hummingbird
Common Flicker
Pileated Woodpecker (SC)
Lewis' Woodpecker
Black-billed Magpie
Common Crow
Boreal Chickadee (SC)
Chestnut-backed Chickadee
Bushtit
White-breasted Nuthatch
Red-breasted Nuthatch
Pygmy Nuthatch
Catbird
American Robin
Varied Thrush
Hermit Thrush
Swainson's Thrush
Bohemian Waxwing
Cedar Waxwing
Hutton's Vireo
American Redstart
Brown-headed Cowbird
Evening Grosbeak
Purple Finch
Cassin's Finch
House Finch
Dark-eyed Junco
Chipping Sparrow
White-crowned Sparrow
Golden-crowned Sparrow
Fox Sparrow
Say's Phoebe

TABLE 10 (CON'T.) ANIMALS WHICH ARE FOUND IN RIPARIAN ECOSYSTEMS AT ABOUT THE SAME LEVEL AS OTHER HABITATS

Hairy Woodpecker	Hammond's Flycatcher
Steller's Jay	Western Wood Pewee
Common Raven	Olive-sided Flycatcher
Bewick's Wren	Brown Creeper
Brewer's Blackbird	Winter Wren

Reptiles and Amphibians

Sagebrush Lizard	Ringneck Snake
Southern Alligator Lizard	Striped Whipsnake
Northern Alligator Lizard	Pine Snake
Racer	Western Skink

(ST) = State-listed; Threatened
(SC) = Species of Concern; State-listed, proposed Threatened or Endangered; Sensitive, or proposed Sensitive (31).

The fourth category (Table 11) includes animals which are attracted to open water within or adjacent to riparian ecosystems. This group of 22 birds (12 percent of birds using the riparian ecosystem) orients specifically to the aquatic habitat component rather than the vegetation, and is part of a larger group of animals, such as fish, which are influenced by the stability and quality of the surrounding habitat. Although some of the ducks, geese, gulls, and other water birds in this category also use other bodies of water in non-forested habitats, their numbers would be reduced were these habitats made unsuitable.

In summary, most wildlife find habitats within riparian ecosystems which provide all or part of their life needs. In fact, of animals which use riparian ecosystems, 69 percent of the mammals either require or prefer them, as do 63 percent of the birds, and 70 percent of the reptiles and amphibians.

TABLE 11. ANIMALS WHICH ARE ATTRACTED TO OPEN WATER WITHIN OR ADJACENT TO RIPARIAN ECOSYSTEMS

Birds

Common Loon (SC)	Redhead
Horned Grebe (SC)	Ring-necked Duck
Western Grebe	Canvasback
Pied-billed Grebe	Greater Scaup
Double-crested Cormorant	Lesser Scaup
Whistling Swan	Ruddy Duck
Trumpeter Swan (SC)	American Coot
Canada Goose	Wilson's Phalarope
White-fronted Goose	California Gull
Snow Goose	Ring-billed Gull
Ross' Goose	Franklin's Gull

(SC) = Species of Concern; State-listed, proposed Threatened or Endangered; Sensitive, or proposed sensitive (31).

INFLUENCES OF SUCCESSIONAL STAGES ON FISH AND WILDLIFE COMMUNITIES

Fish

Fish habitat can be influenced by different successional stages of riparian vegetation along Type 1-5 streams, lakes and ponds. Members of the Fisheries Sub-committee identify eight features or processes that contribute to fisheries habitat (Table 12).

Matrices 1 to 7 illustrate, by water type, the relative contribution of fish habitat components derived from successional stages of riparian vegetation. The successional stages are those described in Chapter 2. The matrix for Type 3 streams (Matrix 3) is shown in this text. The remaining matricies (Matrix 1, 2, 4-7) are contained in Appendix B.

Table 13 illustrates the importance of each habitat component within each water type. Streams and lakes are treated separately.

Matrices 8 to 15 are a composite of Table 13 and matrices 1 to 7. They demonstrate overall habitat quality as it is influenced by bank vegetation at differing successional stages and within different water types. Here, also, the matrix for type 3 streams is provided in this text (Matrix 10). The remaining matricies (Matrix 8, 9, 11-15) are contained in Appendix B.

Note that residual effects were not considered. For example, in the devegetated stage banks may be undercut and woody debris may be in the water. However, neither component will be derived from the riparian vegetation until at least the shrub dominated stage for bank undercutting and until the pole-sapling, young stage for input of woody debris.

The following example illustrates how these matrices were developed. Consider woody debris in a Type 3 stream. Matrix 3 shows that woody debris is not provided to the stream until sometime during the pole sapling-young successional stage. On Table 13 woody debris has a high importance. Therefore habitat quality in terms of woody debris provided by the bank vegetation at the pole sapling -young stage ranks from poor (none) to medium. When the other components at this stage are likewise ranked, the total habitat quality, ranges from low to medium (Matrix 10).

TABLE 12 COMPONENTS OF FISHERIES HABITAT CONTRIBUTED BY RIPARIAN VEGETATION

Woody Debris - any piece of wood large enough to influence water flow in a given water type (i.e. woody debris in a Type 5 stream would be much smaller than in a Type 1 stream).

Organic Litter - twigs, needles and leaves which enter a body of water to be utilized in the stream's energy cycle.

Terrestrial Invertebrates - insects, worms, spiders, etc., which inhabit or frequent the riparian zone and which inadvertantly enter a stream to be consumed by fish.

Bank Cover - overhanging vegetation, undercut banks or shade provided by vegetation which provides hiding cover for fish.

Thermal Control - shade produced by riparian veggetation which moderates daily maximum and minimum temperatures and reduces the ranges of temperature fluctuation.

Bank Stability - soil binding capacity of root systems, water energy dissipation during overbank flows; the ability of the vegetation to maintain stable banks.

Sediment Trapping - the ability of the vegetation to protect a stream from upland debris avalanches; to trap sediment on the flood plain during overbank flow and the ability of instream woody debris to retard sediment transport.

Solar Input - the amount of sunlight reaching the water surface and its effect on instream energy production.

MATRIX 3. RELATIVE CONTRIBUTION OF FISH HABITAT COMPONENTS FROM SUCCESSIONAL STAGES OF RIPARIAN VEGETATION (TYPE 3 STREAM)

	...SUCCESSIONAL STAGE...						
HABITAT COMPONENT	deveg-etated	grass, forb-shrub	pole-sapling young/conif.	pole-sapling young/hrwd.	mature/ conifer	mature/ hrwd.	old growth
WOODY DEBRIS	0	0	1-2	1-2	2-3	2-3	3
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	1	2-3	1	1-2	2	2	3
BANK COVER	0	0	1-2	2-3	3	3	3
THERMAL CONTROL	0	0-2	1-3	2-3	2-3	2-3	2-3
BANK STABILITY	0	1-2	2-3	2-3	3	3	2-3
SEDIMENT TRAPPING	0	1-3	1-2	1-2	2-3	2-3	3
SOLAR INPUT	3	1-3	0-2	0-1	0	0	0
Total	4	5-14	8-17	11-18	16.5-19.5	17-20	18.5-21

CONTRIBUTION : 0 - none recognized; 1 - low; 2 - medium; 3 - high

TABLE 13. IMPORTANCE OF FISH HABITAT COMPONENTS BY WATER TYPE

	COMPONENT	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5
STREAM	WOODY DEBRIS	3	3	3	3	3
	ORGANIC LITTER	1-2	2	3	3	1
	TERRESTRIAL INVERTEBRATES	1-2	2-3	3	1	0
	BANK COVER	2	2-3	3	0	0
	THERMAL CONTROL	1-2	3	3	3	1
	BANK STABILITY	3	3	3	3	3
	SEDIMENT TRAPPING	3	3	3	3	2
	SOLAR INPUT	3	3	3	0	0
LAKE OR POND	WOODY DEBRIS	1-2	3	3	-	-
	ORGANIC LITTER	1	3	3	-	-
	TERRESTRIAL INVERTEBRATES	1-2	2	3	-	-
	BANK COVER	1-2	2	3	-	-
	THERMAL CONTROL	1	3	3	-	-
	BANK STABILITY	2	1	2	-	-
	SEDIMENT TRAPPING	1	3	3	-	-
	SOLAR INPUT	1	1-2	1-2	-	-

IMPORTANCE: 0 -None Recognized; 1 - Low; 2 - Medium; 3 - High

MATRIX 10. FISH HABITAT QUALITY RELATIVE TO SUCCESSIONAL STAGES OF RIPARIAN VEGETATION [1/]

(TYPE 3 STREAM)

HABITAT COMPONENT	devegetated	grass-forb-shrub	pole-sapling-young/conif.	pole-sapling-young/hdwd	mature/conif	mature/hdwd	old growth
WOODY DEBRIS	0	0	3-6	3-6	6-9	6-9	9
ORGANIC LITTER	0	0-3	3-6	6	7.5	9	7.5-9
TERRESTRIAL INVERTEBRATES	3	6-9	3	3-6	6	6	9
BANK COVER	0	3-6	3-6	6-9	9	9	9
THERMAL CONTROL	0	0-6	3-9	6-9	6-9	6-9	6-9
BANK STABILITY	0	3-6	6-9	6-9	9	9	6-9
SEDIMENT TRAPPING	0	3-9	3-6	3-6	6-9	6-9	9
SOLAR INPUT	9	6-9	0-6	0-3	0	0	0
TOTAL	12	21-39	24-51	33-54	49.5-58.5	51-60	55.5-63

CONTRIBUTION X IMPORTANCE = RELATIVE HABITAT QUALITY

CONTRIBUTION	IMPORTANCE
0 - none	0 - none recognized
1 - low	1 - low
2 - medium	2 - medium
3 - high	3 - high

1/ See text for explanation of matrix.

Wildlife

Wildlife species diversity is one tool biologists often use to express the relative "richness" of different types of habitat (21). Diversity is most simply determined by counting the number of wildlife species using each habitat type and comparing them; the habitat type with more species is considered "richer". It must be remembered that the following graphs represent a situation where each successional stage is viewed in isolation. Actually, the use of a successional stage by many species is also related to the presence of other stages nearby such as occurs in a mosaic of different aged stands, or naturally in the mature or old growth condition.

Species diversity alone, however, does not illustrate the dynamic nature of changes in wildlife community composition that occur with changes in habitat. The following graphs display, not only wildlife species diversity in each successional stage following clear-cut harvest, or other complete vegetation removal, but also show the number of species which will use or not use the area as the vegetation changes over time. This parameter is used as a measure of the stability of an ecosystem. The greater the turnover in number and kind of wildlife species the less stable is the community (21). Unstable communities display widely fluctuating population numbers and favor animals such as small mammals and some birds which are short-lived but produce many young (107). Ecosystems increase in stability with maturity (21) favoring the larger, longer -lived animals such as carnivores (107).

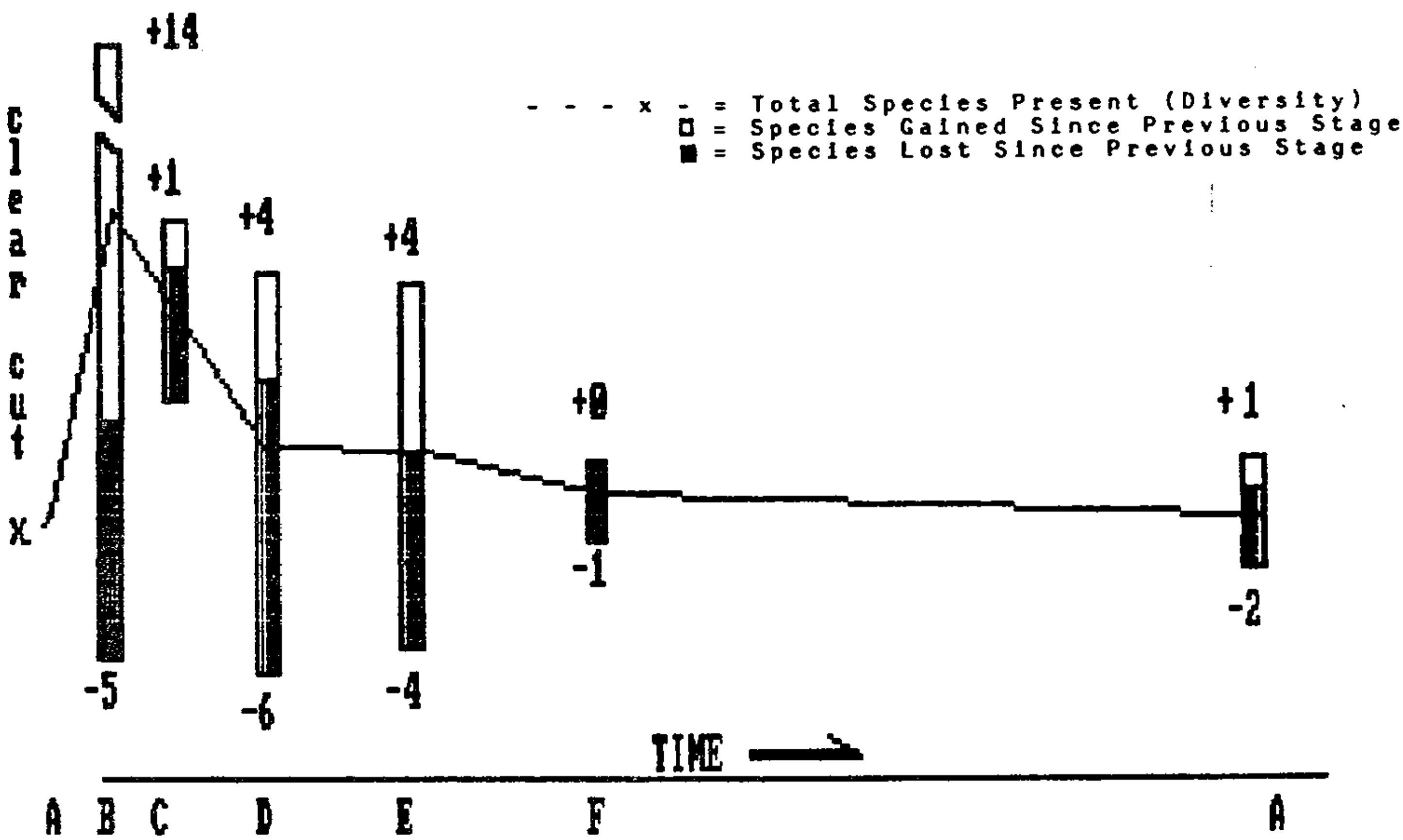
The graphs show that, for major groups of wildlife species, diversity is greater in the earlier successional stages, though the peak lasts a relatively short proportion of a normal rotation. However, the number of wildlife species entering or leaving the system is also highest in these stages making them the most unstable.

Figure 9. MAMMAL SPECIES DYNAMICS AND RELATIVE DIVERSITY THROUGH A CLEARCUT TIMBER HARVEST ROTATION

Mammals as a group respond positively to openings in the forest environment. The highest number of mammalian species can be found in new clearcuts or natural openings. The number of species drops slightly as the stand begins to close. In both hardwood- and coniferous-dominated riparian areas, the number of mammalian species present may drop 10 percent by the time the stand reaches the pole stage and an additional 5 percent when the stand is over-mature.

The relationship of mammalian species diversity to forest succession is made complex since many species prefer a variety of stages. The maximum number of mammalian species present in forest openings is influenced by adjacent canopy and understory conditions. Large openings may have very little interior use for many species.

<u>NOTE</u>: The reader is referred to Table 14 to determine the total number of wildlife species for each successional stage.



A = Old Growth
B = Grass-forb
C = Shrub-seedling
D = Pole-sapling
E = Young Forest
F = Mature Forest

Figure 10. REPTILE AND AMPHIBIAN SPECIES DYNAMICS AND RELATIVE DIVERSITY THROUGH A CLEARCUT TIMBER HARVEST ROTATION

Amphibians as a group orient similarly to hardwood and coniferous forest succession in the riparian zone. Most amphibians find optimum habitat in stands older than 100 years. When a forested riparian area is clearcut harvested, the number of amphibian species using the area will drop by about 20 percent until the canopy of the yound stand begins to close. A further 13 percent reduction in numbers of amphibian species occurs during the pole-sapling stage. As the stand becomes a young forest, more amphibian species reinhabit the area bringing the number of species back to 87 percent of that found in older stands. Full use by the entire amphibian group is not achieved until stands become mature.

Amphibians are tied to riparian habitat more closely than any other group of species due to their reproductive requirements. The aquatic system usually provides their reproductive substrate and the tree canopy and sub-canopy maintain the cool, moist microclimate necessary for thermoregulation and respiration.

The total number of reptile species changes little in response to changes in the forest environment though species compostion varies. It should be noted that some species of reptiles are dependent on the aquatic system for feeding. Also many species will not use openings without adjacent closed canopy areas for thermoregulation.

NOTE: The reader is referred to Table 14 to determine the total number of wildlife species for each successional stage.

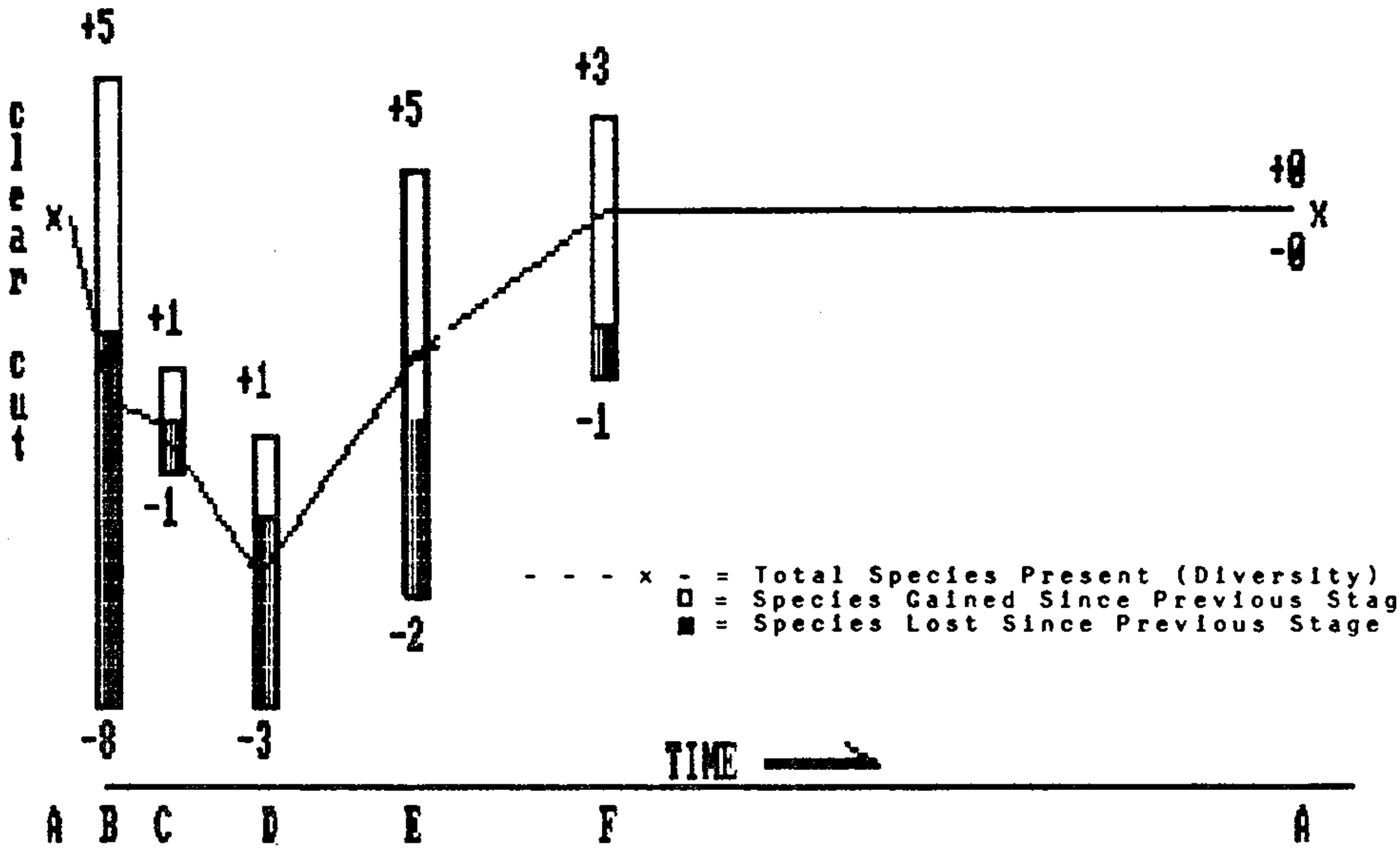
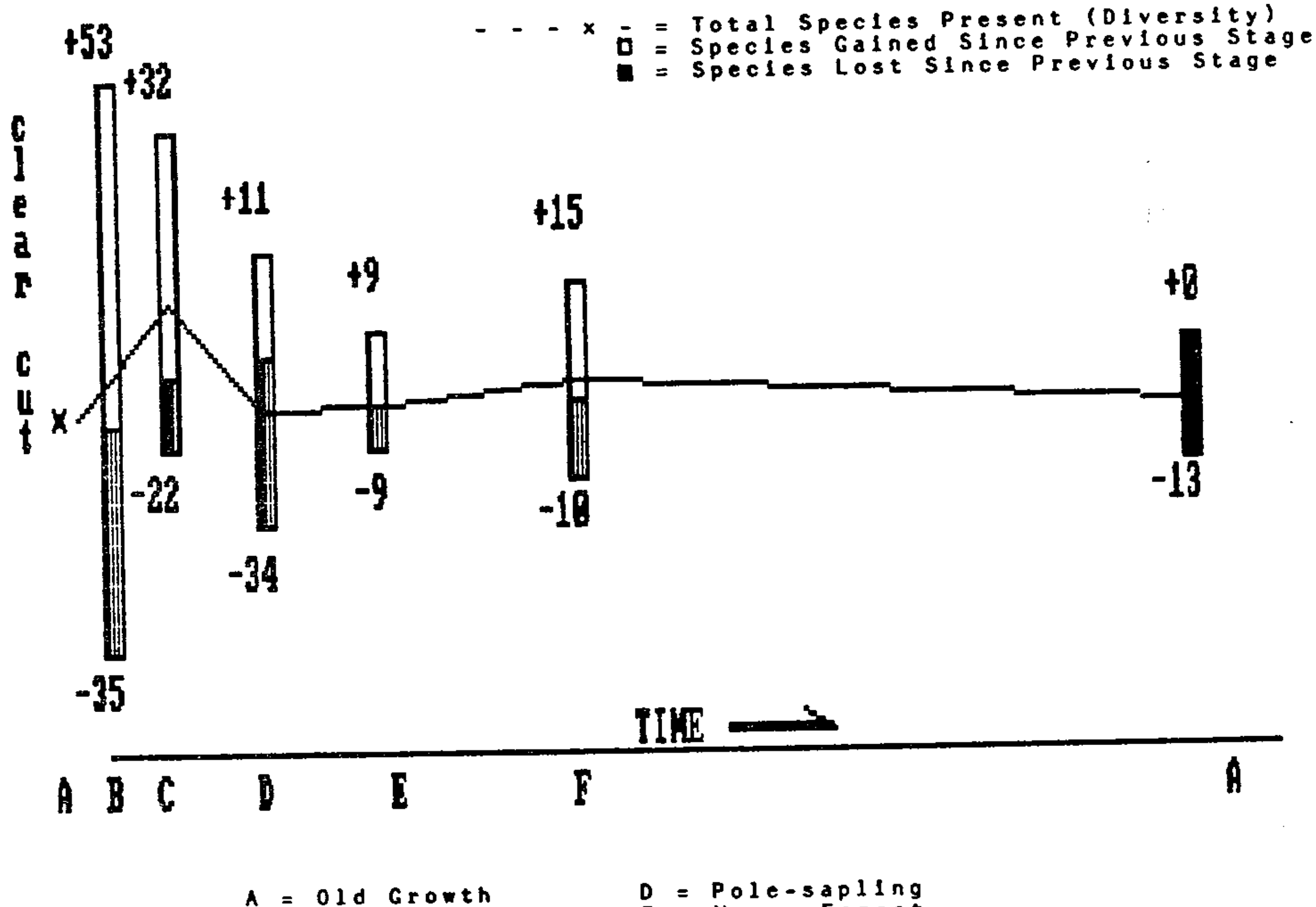


Figure 11. BIRD SPECIES DYNAMICS AND RELATIVE DIVERSITY THROUGH A CLEARCUT TIMBER HARVEST ROTATION

Bird species diversity is similar in both hardwood- and coniferous-dominated riparian areas, being highest in shrub-dominated stages. As the stand reaches the pole-sapling stage, the number of species present declines about 20 percent, then increases about 6 percent as the stand reaches maturity. By the time the stand is overmature, diversity declines again to 70-75 percent of that found in the shrub-dominated stage.

NOTE: The reader is referred to Table 14 to determine the total number of wildlife species for each successional stage.

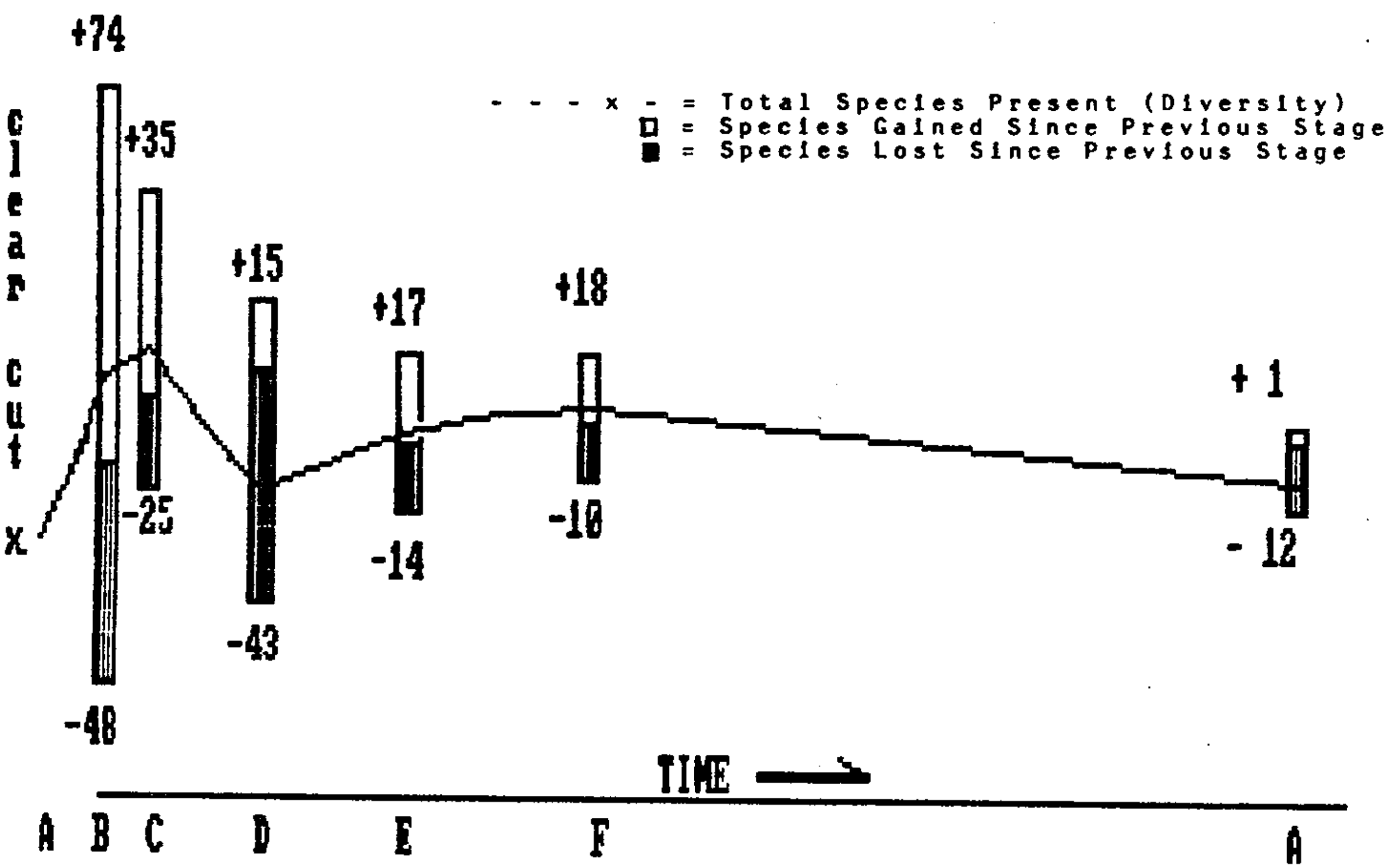


A = Old Growth
B = Grass-forb
C = Shrub-seedling
D = Pole-sapling
E = Young Forest
F = Mature Forest

Figure 12. TOTAL WILDLIFE SPECIES DYNAMICS AND RELATIVE DIVERSITY THROUGH A CLEARCUT TIMBER HARVEST ROTATION

In general, the total species diversity is greatest in early successional stages. This graph showing the total of all species is the least informative because the large number of bird species masks the effects of forest succession on the smaller number of mammals, amphibians, and reptiles.

NOTE: The reader is referred to Table 14 to determine the total number of wildlife species for all successional stages.



A = Old Growth
B = Grass-forb
C = Shrub-seedling
D = Pole-sapling
E = Young Forest
F = Mature Forest

TABLE 14. NUMBER OF WILDLIFE SPECIES USING SUCCESSIONAL STAGES

Successional Stage	Amphibians	Reptiles	Mammals	Birds	Total Species
.... Hardwood					
Herb.	17	14	66	114	211
Grass/ Forb	12	10	59	69	150
Shrub	12	10	57	90	169
Pole/ Sapling	10	10	54	75	149
Young	13	11	54	76	154
Mature	15	11	54	80	160
Old Growth	15	11	51	67	144
.... Coniferous					
Grass/ Forb	12	12	62	91	177
Shrub	12	12	60	102	186
Pole/ Sapling	10	12	56	79	157
Young	13	12	56	80	161
Mature	15	12	55	85	167
Old Growth	15	12	53	72	152

The total number of species occurring in forests of Washington are as follows: Amphibians = 21; Reptiles = 16; Mammals = 75; Birds = 174; total = 286.
[Adapted from Guenther & Kucera, (122)]

CHAPTER 4

FOREST PRACTICES AND RIPARIAN HABITAT - BIOLOGICAL RELATIONSHIPS

INTRODUCTION

In previous discussions, we have described the diverse, complex, and dynamic interactions between fish and wildlife and the vegetation that comprise their habitat in riparian ecosystems. Timber harvest, road building and the complement of other practices that accompany the growing of a crop of trees alter these interactions.

Such alterations can benefit some types of animals by creating new habitat. It can also be damaging to others through direct mortality or by reduced ability to survive in an altered habitat. In this chapter we will discuss the types, causes and significance of changes in riparian habitat induced by forest practices.

We have elected to discuss the changes in riparian habitat through the use of matrices. Variability in forest practices applied, physical and biological conditions, as well as, the large number of fish and wildlife species precludes a detailed life history description for all species involved. Examples of the interactions between forest practices induced changes and selected species are provided in narrative descriptions following each set of matrices.

BACKGROUND - EXISTING CONDITIONS

Commercial forest land in this state totals approximately 17.8 million acres. Ownership, in million of acres, is as follows:

(5.1) U.S. Forest Service;
(1.6) Bureau of Indian Affairs;
(0.5) Other Federal;
(1.8) State of Washington;
(4.3) Forest Industry; and,
(4.5) Other Private.

On an average, about 325,000 acres (3%) of the nonfederal land base of 10.6 million acres are harvested annually. Partial cut methods are used on approximately 60 percent of these acres with clearcutting on the remainder. Clearcut harvesting predominates west of the Cascade mountains. Timber harvesting on private lands is dominated by large industrial ownerships (121).

Class III and Class IV timber harvest and road construction, as well as, site preparation, reforestation and chemical applications are conducted under approximately 8-9,000 separate forest practices applications yearly.

The number of operations with potential for affecting riparian ecosystems can not be readily determined from available records. The most current information available for miles of streams, by water type, is nearly 19,000 stream miles for all ownerships in western Washington (119). No estimate is available for eastern Washington.

A 1976 estimate of stream miles affected annually by forest practices statewide, all ownerships, is 1,140 stream miles (119). On a percentage of ownerships basis, this indicates that about 800 miles of stream were affected annually on nonfederal lands at that time.

Additional information indicates that approximately 60 percent of all activities proposed under forest practices applications potentially affect water quality in Type 1 through Type 5 water (120). This figure is not directly comparable to riparian ecosystems unless it is assumed that practices which affect water quality also affect riparian habitat, and that operations proposed under forest practices applications are conducted within application period (one year).

ASSUMPTIONS

Two assumptions are made in order to assess forest practices induced changes in riparian habitat.

First, we assume that the Forest Practices Rules and Regulations (Chap. 222 WAC) are complied with during all forest operations. Other laws and regulations which apply to forest practices are not considered for the purposes of this report.

Second, we assume that riparian areas are unmanaged so that a mix of plant communities occur. This mix provides vertical layering and horizontal edges, thus, a diverse habitat. Another way of viewing this assumption is that riparian ecosystems contain big trees as well as understory and herbaceous cover.

TYPES OF FOREST PRACTICES

Four catagories of forest practices are used, including; a. Road and Landing Construction; b. Timber Harvest; c. Site Preparation and Fuels Management; and, d. Timber Stand Improvement.

TABLE 15. LIST OF FOREST PRACTICES WHICH MAY ALTER RIPARIAN ECOSYSTEMS (RE)

A. <u>ROAD AND LANDING CONSTRUCTION</u>

1. Planning, Design and Location
2. Construction
   a. stream crossings
3. Use
4. Maintenance
5. Abandonment

B. <u>TIMBER HARVEST</u>

1. Harvest Unit Layout - Yarding System - Timing - Volume/Area Involved -
2. Rotation Age
3. Removal of Vegetation from RE
4. Felling Timber Directly into Water
5. Skidding and Yarding over or through Water
6. Felling and Yarding on Steep Slopes Above Water
7. Stream Cleanout of Recent Logging Debris
8. Salvage Logging

C. <u>SITE PREPARATION AND FUELS MANAGEMENT</u>

1. Slash Burning
   a. with prior treatment with dessicants
   b. fire trails
2. Scarification
3. Wet Site Drainage
4. Secondary Harvest Activities to Reduce Fuels Loading (i.e. firewood)

D. <u>TIMBER STAND IMPROVEMENT</u>

1. Fertilization
2. Pesticide Application
   a. herbicides
   b. insecticides and rodenticides
3. Thinning
   a. pre-commercial
   b. commercial
4. Sanitation Cutting (e.g. diseased tree removal)
5. Timber Type Conversion

Note: Cumulative effects occurring in Riparian Ecosystems is an issue identified for further consideration. The FP Board has commissioned a study specifically to address cumulative effects. The scope of this study involves all forest land and all physical and biological elements of the environment.

These catagories are subdivided into related activities (Table 15) and form the basis for identifying specific habitat changes as related to types of forest practices.

FOREST PRACTICES/HABITAT CHANGE MATRICES

Matrices 16 and 17 in this chapter contain an identification of relationships between riparian habitat for wildlife and fish, and forest practices. Information in these matrices is organized from the left-hand column to the right.

The first category presents identification of potential change in riparian habitat. Forest practices associated with to those changes are listed in the second column from the left. Number and letter designations are used for forest practices in the remaining columns. These may be identified by referring to "Forest Practice" column or from Table 15, List of Forest Practices Which May Alter Riparian Ecosystems.

Relationships between forest practices and elements of wildlife or fish habitat are listed in the third column from the left on each matrix ("How Change Occurs"). The final two columns provide statements regarding the processes involved in altering habitat ("Effects") and the significance, duration and scope of the change occurring ("Significance"). Terms used in the "Significance" column are defined as follows:

Temporary or Short-term refer to effects occurring during all or part of a single rotation. Effects may last from a few years to several decades.

Permanent effects infer continuing forest practices over several rotations. The changes last as long as practice(s) are used.

Scope refers to the extent to which a particular practice occurs throughout Washington and, therefore, infers the magnitude of that practice's effects on wildlife.

MATRIX 16. Potential Changes in Riparian Ecosystems - Sources, Effects, and Significance to Wildlife

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effects on Wildlife	Significance
Amount, Kind, and distribution of cover is changed.	A. Road and Landing Construction: 2. Construction 5. Abandonment	A2; B3; D5 Cover is removed	A2; B3; D5 Roads in use and rights-of-way and timber harvest result in loss of tree cover. Some wildlife seek cover, food, or access to water elsewhere; redistributes animals.	A2; B3; D5 Direct mortality and temporary reduction of some small mammals, reptiles and amphibians with small home ranges. Permanent loss of cover on roads in use and rights-of-way. Timber harvest causes temporary increase in animals associated with early seral vegetation; temporary reduction in wildlife preferring forest canopy. Scope: major
	B. Timber Harvest: 2. Rotation Age 3. Removal of vegetation in RE (clear cut) 8. Salvage logging C. Site Preparation and Fuels Management: 3. Wet site drainage 4. Secondary harvest activities to reduce fuel loading (e.g. firewood) D. Timber Stand Improvement: 2. Fertilization, herbicides 3. Thinning 4. Sanitation cutting 5. Timber type conversion	B2; C4; D2, 3,4 Structural diversity and/or density of cover is changed.	B2; C4; D2, 3,4 The shorter the rotation, the briefer the period of time in which an area will be usable as cover. Structural diversity of cover and wildlife species diversity are reduced through most of the rotation. Reforestation, fertilization and herbicide use increase the rate of cover development, and re-occupation by animals associated with closed canopy conditions. Reduces abundance of species associated with multi-layered stands. When cover density is reduced, the ability of some wildlife to hide or avoid extreme weather is reduced.	B2; C4; D2, 3,4 Permanent change is species composition in local areas over time. Permanent reductions in abundance of species associated with older forest stands. Scope: major Temporary increase in wildlife associated with closed canopy conditions; reduction in wildlife preferring early seral vegetation. Permanent change in species may be liminated in local areas. Scope: major Produces environmental stress resulting in lower reproduction, growth rate, and increased nutritional needs, Increases liklihood of predation. Scope: moderate

MATRIX 16. (Continued) Pg. 2

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effects on Wildlife	Significance
Amount, kind, and distribution of cover is changed. (continued)		C3; D2, 3, 5 Vegetative diversity of cover is changed.	C3; D2, 3, 5 Reforestation, fertilization, herbidide use, and thinning directly encourage site domination by conifers. Wildlife community composition changes to feature species preferring coniferous stands.	C3; D2, 3, 5 Permanent changes in wildlife species composition over time; some species may be eliminated locally. Increased abundance of wildlife preferring conferous cover. Scope: major
			Wet site drainage and timber type conversion remove existing plant community and shift wildlife species composition to feature animals preferring coniferous stands.	Reduction in wildlife species diversity. Permanent change in wildlife species composition over time; some species may be eliminated locally. Scope: moderate
		A5 Cover is restored	A5 Wildlife re-inhabit abondoned roads and rights-of-way as cover develops.	A5 Animals return to fully using their habitat. Areas previously avoided can be re-inhabited. Scope: minor

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effects on Wildlife	Significance
Amount, kind, and distribution of food is changed.	A. <u>Road and Landing Construction</u>: 2. Construction 5. Abandonment	A2; B3; C1,2: D5 Food is removed	A2, B3; C,2; D5 Permanent elimination of food on the surface of roads in use. Following timber harvest, animals seek food elsewhere; re-distributes wildlife populations that feed on ground vegetation.	A2; B3; C1,2; D5 Short-term reduction in food available for some species; permanent loss on the surface of roads in use. Temporary reduction in carrying capacity of affected area. Scope: major
	B. <u>Timber Harvest</u> 2. Rotation Age 3. Removal of vegetation in RE (Clear Cut 8. Salvage logging	B2, 3,8; C1, 2, 3, 4; D2, 3, 4, D5 Diversity and/or density of food is changed	B2, 3, 8; C1, 2, 3, 4; D2, 3,4,5 Clear cutting, slash burning, and scarification increase both the diversity and abundance of nutritious food thereby increasing the carrying capacity for animals which feed on ground vegetation.	B2, 3, 8; C1,2,3,4; D2,4,4,5 Temporary increase in diversity and abundance of wildlife associated with early seral vegetation Scope: major
	C. <u>Site Preparation and Fuels Management</u> 1. Slash burning 2. Scarification 3. Wet site drainage 4. Secondary harvest activities to reduce fuel loading (e.g. firewood)		Short rotation age, salvage, secondary harvest activities, thinning and sanitation cutting increase the amount of time early seral vegetation occupies the site, thereby increasing the carrying capacity for wildlife.	Temporary increases in abundance and animals feeding on early seral vegetation. Short rotations may locally eliminate some species dependent on food in older forest stands. Scope: major

MATRIX 16. (Continued) Pg. 4

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effects on Wildlife	Significance
The amount, kind and distribution of food is changed. (continued)	D. Timber Stand Improvement: 2. Fertilization, herbicides 3. Thinning 4. Sanitation cutting (e.g. diseased tree removal) 5. Timber type conversion		Following a short-term increase in forage, thinning, fertilization, wet site drainage, and timber type conversion encourage rapid conifer domination reducing diversity and abundance of food.	Species diversity reduced. Abundance of wildlife preferring hardwoods or early seral vegetation reduced. Some species may be eliminated over time. Scope: moderate
		A5 Food is restored.	A5 Wildlife forage on road surface as re-vegetation occurs.	A5 Allows temporary increase in feeding habitat until cover dominates Animals return to fully using their habitat. Areas previously avoided can be re-inhabited. Scope: minor

MATRIX 16. (Continued) (5)

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effects on Wildlife	Significance
There are fewer snags	A. Road and Landing Construction:	A2; B2,3,8; C1,4; D3,4	A2; B2,3,8; C1,4: D3,4	A2; B2,3,8: C1,4; D3,4
	2. Construction	Snags are cut, knocked over, or burned	Eliminates denning and nesting habitat of cavity users. Reduces food for wildlife which feet on insects in decaying wood. Eliminates perches preferred by large birds of prey and some songbirds.	Permanent loss of habitat on the surface of roads in use and rights-of-way. Magnitude depends on open road density. Scope: moderate
	B. Timber Harvest:	B2,8: C1,4; D3,4	B2,8; C1,4; D3,4	B2,8; C1,4; D3,4
	2. Rotation age 3. Removal of vegetation in RE (clear cut) 8. Salvage logging	Size and nubmer of snags are reduced.	Reduces denning and nesting habitat of cavity users. Reduces food for wildlife which feed on insects in decaying wood. Reduces availability of perches preferred by large birds of prey.	Causes habitats to become marginal (less effective); fewer animals can be supported. Scope: moderate Some species eliminated locally under short rotations over time. Scope: major
	C. Site Preparation and Fuels Management: 1. Slash burning 2. Scarification 4. Secondary harvest activities to reduce fuels loading (e.g.) firewood)			
	D. Timber Stand Improvement: 3. Thinning 4. Sanitation cutting (e.g. diseased tree removal)			

MATRIX 16. (Continued) Pg. 6

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effects on Wildlife	Significance
There are less large down material	A. Road and Landing Construction: 2. Construction 4. Maintenance 5. Abondonment	A2: B3, 8; C1,3; D5 Existing large down material is removed mechanically, burned or otherwise destroyed.	A2; B3,8; C1,3; D5 Eliminates denning, nesting, resting, and courtship habitats for some wildlife. Reduces food supply which is found in downed wood.	A2; B2,8; C1,3; D5 Temporary reduction in habitat effectiveness for some wildlife species. Reduction in population numbers due to marginal habitat. Scope: major
	B. Timber Harvest: 2. Rotation age 3. Removal of vegetation in RE (Clear Cut)	A4; B2, 8; C4; D3b, 5 Potential for large down material is reduced or prevented by shorter rotation and other forest practices.	A4; B2,8; C4; D3b, 5 Reduces denning, nesting, resting and courtship habitats for some wildlife. Reduces food supply which is found in downed wood.	A4; B2,8; C4; D3b, 5 Permanent reduction in number of species and abundance of some species which used down wood as habitat. Some species may be eliminated under short rotations over time in an area.
	C. Site Preparation and Fuels management: 1. Slash burning 2. Scarification 4. Secondary harvest activities to reduce fuels loading (e.g. firewood)			
	D. Timber Stand Improvement: 3b. Commercial thinning 5. Timber Type converstion			

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effects on Wildlife	Significance
Travel to and along water is affected.	A. <u>Road and Landing Construction:</u> 2. Construction 3. Use 4. Maintenance 5. Abandonment	A2, 3, 4 Trees and brush are removed. Vegetation is sprayed or removed on rights-of way.	A2, 3, 4 Reduces access to water needed by terrestrial animals and some ground-nesting birds. Disrupts feeding habits of seed or plant-eating wildlife. Increases hazard from traffic and poaching to animals crossing or travelling along roads.	A2, 3, 4 Roads is use results in permnent changes in wildlife pattern of use in adjacent areas; can cause animals to concentrate in more marginal habitat. Scope: moderate Increases direct mortality. Scope: moderate
	B. <u>Timber Harvest:</u> 2. Rotation age 3. Removal of vegetation in RE (clear cut) 8. Salvage logging	A5 Habitat is restored	A5 Wildlife re-inhabit abandonment roads and rights-of-way as food and cover develop.	A5 Animals return to fully using their habitat. Areas previously avoided can be reinhabited. Scope: minor
	C. <u>Site Preparation and Fuels Management:</u> 4. Secondary harvest activities to reduce fuels loading (e.g. firewood)	B2,3,8; C4; D3,4,5 Vegetation is removed or reduced in density.	B2,3,8; C4; D3,4,5 Exposes prey species to predators. Increases edge where adjacent areas contain trees and shrubs. Removal of dense cover causes some animals to alter travel routes or access water elsewhere.	B2,3,8; C4; D3,4,5 Temporary benefits to predators and wildlife which feed in eary seral vegetation. Scope: major Temporary changes in wildlife life pattern of use or habitat; can cause animals to concentrate in more marginal habitat. Scope: major
	D. <u>Timber Stand Improvement:</u> 3. Thinning 4. Sanitation cutting (e.g. diseased tree removal)			

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effects on Wildlife	Significance
Disturbance and harassment by humans are increased.	A. Road and Landing Construction: 2. Construction 3. Use 4. Maintenance 5. Abandonment	A2,4; B8; C3,4; D3,4 Trees, brush and other vegetation are removed. Numbers of humans using area is increased.	A2,4; B8; C3,5; D3,4 Potentially acceptable nesting, resting, hiding, feeding, or calving and fawning areas are used less because of noise and other disturbance.	A2,4; B8; C3,4; D3,4 Where preferred habitat is in short supply, temporary impacts on wildlife distribution can be expected. Reduction in production and survival of young. Scope: minor
	B. Timber Harvest: 3. Removal of vegetation in RE (clear cut) 8. Salvage logging C. Site Preparation and Fuels Management: 1. Slash burning 2. Scarification 4. Secondary harvest activities to reduce fuels loading (e.g. firewood)	A3; B3; C1 Trees, brush and other vegetation are removed. Vehicle travel is increased number of humans using area is increased	A3; B3; C1 Potentially acceptable nesting, resting hiding, feeding, or calving and fawning areas are not used because of noise and disturbance and lack of cover. Wildlife are directly killed or injured by vehicles. Game animals are more vulnerable to hunting and poaching.	A3; B3; C1 Long-term reduction in carrying capacity of habitat redistribution of wildlife into more marginal areas; long-term reduction in production and survival of young. Scope: moderate Direct mortality impacts related to open road density. Scope: minor
	D. Timber Stand Improvement: 3. Thinning 4. Sanitation cutting (e.g. diseased tree removal) 5. Timber type conversion	A 5 Disturbance and harassment is reduced.	A 5 Wildlife reinhabit areas as disturbance ceases.	A 5 Animals return to fully using their habitat. Areas previously avoided can be reinhabited. Scope: minor

POTENTIAL CHANGES IN RIPARIAN HABITAT - WILDLIFE

Previous discussions cover the generalized effects of forest management activities in riparian ecosystems on wildlife. To provide a more in-depth description of these influences, species which represent broad groups of wildlife were selected, and their responses to habitat changes described in the following narratives.

In considering the influence of forest management on wildlife in riparian ecosystems, it should be recognized that riparian ecosystems will constitute only a portion of the habitat used by some wildlife with extensive home ranges, though this part of their home range can be of disproportionately greater value. The entire habitat of many other species is contained within riparian ecosystems.

Although natural disturbances and forest practices have altered many riparian areas in Washington, for the purpose of this study, we visualized riparian habitats as areas with a variety of trees, shrubs, and ground vegetation arranged in complex vertical and horizontal structures; they are adjacent to water and upland areas, and because of their elongate shapes, interconnect with these habitats as "edges" which are highly valued by most wildlife; they contain irregularly distributed small openings and relatively large volumes of dead wood, both standing as snags and as down logs.

This description most often suits habitat adjacent to Types 1, 2, and 3 waters. It may occur, however, with all water types.

The narratives thus describe responses of representative wildlife species to modification of "natural" riparian areas. This habitat type currently is of very limited distribution on state and private lands, though any managed stand has the potential for returning to its natural stand condition over time. Because of the limited distribution of this habitat, and due to its importance for some animals, species orienting strongly to older stand conditions were generally selected.

Cover

Fisher

Fishers in Oregon use cedar swamp, mature conifer, and tanoak habitats. They are considered to be more abundant in western Washington than in Oregon, and also occur in the far northeast corner of eastern Washington (43). Larrison (44) described fisher habitat as undisturbed virgin forest at low to intermediate elevations, particularly near water. Since the home range of a fisher may be from one to four square miles, riparian ecosystems constitute only a portion of their habitat.

Fishers seek to meet all of their life needs under cover of mature or overmature forests. They find hiding and thermal cover under down logs and root wads of blowndown trees. Dens for rearing young are found in hollow trees as much as 40 feet from the ground (43). Fishers hunt under cover of a canopy. Their prey includes snowshoe hare, porcupine, and various small mammals, birds, amphibians, and reptiles. They swim readily and seek prey where they are most abundant which is often in riparian zones. Maser (43) states, "Fisher ... appear to be strongly reluctant to travel through areas lacking overhead cover, hence they are definitely forest dwellers by nature".

Fishers are wary, solitary animals sensitive to disturbance. Road construction and use alters their patterns of activity within their home range and may force them to concentrate their activities in less than optimal habitat. Fishers seldom follow roads as some other predators do; when they do, they most often intercept them near ridgetops under a forested canopy (43).

Fishers have been observed to travel a mile around a frozen lake under cover of tree canopy rather than cross over (43). Open areas such as meadows, frozen lakes, and clearcuts are avoided. Complete removal of vegetation in riparian ecosystems, therefore, reduces total habitat available for some years. This forces them to expand their home ranges, expend more energy, and may lead to lower production of young.

Forest practices such as fertilization, herbicide use and thinning (applied outside of streamside management zones but within riparian ecosystems) increase the rate of cover re-development, but encourage conifer dominance. Diversity and numbers of prey species are lower in even-aged, coniferous stands, which can result in fewer fishers.

Areas managed under short rotations will not attain a size and age great enough to provide hollow trees and down logs large enough for denning. Again, this reduces the effectiveness of the habitat to support fishers.

Black-tailed Deer

For animals like black-tailed deer and elk, riparian ecosystems normally constitute only a portion of their home range. During a given season of the year Roosevelt elk will use an area of 1,000 to 6,000 acres in size while black-tailed deer normally occupy an area of about 640 acres (45,46). Thus, forest practices in riparian areas in the home range of black-tailed deer have less influence on them than on species with smaller home ranges more narrowly confined to riparian areas. Where availability of water is limited, as in parts of eastern Washington, riparian ecosystems receive proportionately more use by deer and elk than other parts of the home range. Riparian ecosystems also receive heavy seasonal use by elk in the western Cascades (47) and are preferred as calving and fawning habitat in eastern Washington.

Road and landing construction results in the removal of cover in an amount equivalent to the area involved in the road and landing surface and the cleared right-of-way. This constitutes a loss of cover for hiding from predators, particularly man, or for protection from extremes of weather. Because the area affected is limited, the net effect of this cover loss is relatively small, and will depend upon cover conditions in the remainder of the home range.

Timber harvest in the riparian ecosystem has the immediate effect of removing thermal and hiding cover on the affected acreage. The impact of cover removal is dependent on cover conditions in the surrounding area, or in the riparian ecosystem upstream and downstream of the harvest area. If a large amount of the surrounding area has been recently harvested, the removal of cover can force animals to concentrate in remaining areas, reduce the total carrying capacity of the land, and, therefore, reduce the number of deer and elk present (18).

Absence of hiding cover in an area where disturbance by humans is high interferes with patterns of big game use of water. The riparian area is periodically unusable or causes the animals to obtain water at night, when vehicle traffic levels are normally low. The absence of cover also exposes big game to increased hunting, poaching pressure, and predation.

The changes in hiding cover conditions resulting from timber harvest are temporary, since cover re-develops as the regenerating stand develops. Since riparian areas are often some of the more productive sites for growth of vegetation, development of planted conifers, or natural revegetation of hardwood trees and shrubs, is normally rapid. Suitable hiding cover is usually present 10-15 years after harvest (22) and stands begin to modify micro-climatic conditions as trunk size reaches six to eight inches in diameter.

With rotation ages of 80 years or less, old-growth stand conditions will not be present. Old growth conditions result in reduced snow depths compared to cutovers or young stands. These conditions have been shown to be important in providing winter habitat in deep snow areas (48) and their absence may add to winter mortality of black-tailed deer and elk during severe winters (49).

The result of timber stand improvement activities such as thinning or selective harvest is a temporary reduction in cover density, which lessens the ability of the stand to provide hiding cover. Heavy thinnings or selective logging may also temporarily reduce the stand's ability to moderate temperature extremes. The net effect will be lower levels of deer and elk use for some years, and animals may be subject to greater levels of environmental stress which can influence rates of growth, reproduction, and winter survival (49).

Flying Squirrel

Flying squirrels occur throughout forested areas, but often are found in riparian habitats because of the vegetative diversity (50,51,52). A mixture of mature conifer and hardwood trees appears to be optimum flying squirrel habitat (50,53).

Mature trees provide rearing cover, thermal cover, and cover while traveling or foraging. Since flying squirrels are frequent prey of marten, fox, bobcat, owls, and hawks, hiding cover provided by trees is important (51,43, 52). Predation can be a controlling factor on flying squirrel populations when they are at low levels (50).

Complete removal of vegetation from areas in riparian ecosystems leaving patches of forest with interspersed openings affects flying squirrels in at least two ways. First, openings are rarely used due to increased exposure to predators (50,51) so that total available habitat is reduced as is the number of flying squirrels an area can support. Secondly, flying squirrels travel by gliding from tree to tree, and because the distance they can glide is limited, they need a relatively continuous stand of trees (53). In Alaska, flying squirrels were rarely observed to glide across openings greater than 100 feet (53). Abundance of flying squirrels in the Oregon Coast Range is said to be declining due to clearcutting and loss of snag habitat (47).

Since flying squirrels are active at night when road use is minimal, disturbance is probably also minimal. They have been observed gliding across roadways 35 feet wide (53). The major impact from road construction and use is the permanent reduction in food and cover available.

Food

Sharp-shinned Hawk

Sharp-shinned hawks use young even-aged coniferous stands as well as stands with a mixture of deciduous and coniferous trees for nesting. They are considered heavily dependent upon deciduous riparian habitat for feeding due to the abundance of preferred prey there (54). In addition, sharp-shinned hawks require drinking water; nests are usually located within 300 feet of water (55).

Sharp-shinned hawks feed primarily upon small birds captured in flight. They typically perch in trees and pursue birds through the trees as they appear. Three of their most important prey species are warblers, sparrows and robins (55). The habitat preferences of these prey species explains the sharp-shinned hawk's heavy use of deciduous riparian habitat.

Yellow warblers are common summer residents of deciduous riparian habitat. They feed on insects in shrubs and in the upper canopy of trees. Preferred foraging areas include the shrubby vegetation along bogs, marshes, and rivers. These warblers nest in deciduous brush or saplings, but require occasional tall trees nearby to sing and perch (54). Lincoln's sparrows prefer wetlands, open deciduous riparian, and wet meadows with tall herbaceous vegetation; it often nests in willow thickets with wet ground (54). The robin's use of forested habitat includes deciduous riparian and coniferous areas mixed with deciduous trees in early seral stages for feeding and nesting. Moist openings are important as are abundant fruit and berry producing trees and shrubs (54).

Road construction, road use, and logging can cause sharp-shinned hawks to abandon their nests, and causes the direct removal of habitat for their prey. Complete removal of riparian vegetation in small patches surrounded by other successional stages results in increased habitat for the prey of sharp-shinned hawks.

Forest practices which drain wet areas, encourage even-aged coniferous stands, or reduce hardwoods will seriously alter prey abundance and reduce sharp-shinned hawk numbers. Pesticides containing chlorinated hydrocarbons or heavy metals are considered to be primarily responsible for the decline of sharp-shinned hawks in the northwest and nationwide through causing reproductive failure (54,55). Future use of these types of pesticides is expected to be rare in Washington's forests.

Black-tailed Deer

Modification of riparian ecosystems can have major influences on both the quantity and quality of deer food. These effects are primarily associated with the patterns of vegetative succession that follow removal or modification of the forest canopy. Construction of roads and landings eliminates forage production on an area equivalent to the surface of active roads and landings, normally less than 5 percent of the overall area. Rights-of-way normally revegetate after road construction is completed, and while traffic may restrict use, herbaceous vegetation growing on the right-of-way is often attractive to deer and may be used in the absence of high levels of human disturbance.

Timber harvest in the riparian ecosystem results in the reinitiation of plant succession following the disturbance, with a temporary dramatic increase in quantities of herbaceous and shrubby forage plants. Many of these plants are preferred and highly nutritious food for black-tailed deer (46). As the new forest stand develops after harvest, quantities of forage decline to levels approximating pre-harvest conditions.

Actual levels of deer forage present in developing second-growth forests will be dependent on site class, initial conifer stocking density and the frequency and level of intermediate silvicultural treatments like thinning and fertilization. Generally, thinning treatments have the effect of maintaining forage at higher levels than in unthinned stands. Forest fertilization can increase nutritional quality of understory forage plants (56), but may also hasten closure of the forest canopy with associated declines in available forage. In general, intensive forestry on small units has the effect of increasing carrying capacity for deer, due to increased forage levels in managed stands. The use of short rotations results in more area being harvested over time, with a greater proportion of the rotation period supporting high forage production.

The patterns of harvesting the riparian ecosystem and conditions in the remainder of the home range of black-tailed deer have an influence on the utility of this increased forage. Deer tend to remain fairly close to cover when feeding, so large cut-overs are under-utilized during the first several years after harvest. Because of the requirements for both forage and cover, practices which result in large areas of uniform forage or cover conditions will be less productive than a mixture of stand ages. Intact riparian ecosystems tend to support somewhat different vegetation than upland sites and in this regard, add useful diversity to the habitat of an area for black-tailed deer.

Beaver

Beaver spend most, if not all, of their time within riparian ecosystems. In the Sierra Nevada, 90 percent of beaver -cut trees were within 100 feet of water. Beaver maintain vegetative diversity in riparian ecosystems through their activities and may even expand it by constructing dams to impound shallower streams and increase water depth. They do, however, select the broader, lower gradient streams and rarely use streams with a gradient over 15 percent. Suitable habitat for beaver must contain stable aquatic habitat providing adequate water, channel gradient of less than 15 percent, and quality food species present in sufficient quantity (57).

In western Washington, food eaten by beaver includes willow, red alder, salmonberry, cascara, red huckleberry, and Douglas fir. East of the Cascades, Douglas fir, pines and silver fir may be eaten in addition to willow and alder, if the preferred foods are not available. During summer herbaceous and aquatic vegetation supplement the diet (43). As the canopy of trees and shrubs closes, the suitability of available food increases. Optimum vegetation consists of an uneven-aged stand containing woody trees and shrubs in the one to six inches dbh size class with shrubs being greater than six feet in height (57). In order to support a beaver colony, habitat containing the above types and sizes of vegetation should be present along at least one-half mile of stream channel or in one-half square mile around a lake or marsh (57).

Road construction and use in riparian ecosystems will force beaver to confine their activities to nighttime. A more direct effect, though minor in terms of total habitat, is the permanent loss of food from road surfaces and rights-of-way.

Complete removal of vegetation from riparian ecosystems removes beaver's food sources for some years. When vegetation regains the appropriate size and height, it can be more diverse and dense than prior to clearcutting and provide a more abundant food supply. However, clearcutting has the disadvantage of creating a relatively even-aged stand, so that the period of food abundance is followed by one of scarcity. Short rotations, though increasing the total amount of time an area is in forage, can cause a cyclic period of use followed by non-use. This reduces the number which can be supported on an area by increasing the size of the area over which individual beavers must travel for food.

Forest practices which drain wet sites, convert hardwood stands to conifer, or encourage conifer dominance have the greatest impact on beaver. Beaver have been reported to subsist on conifers, but these are generally considered a very poor source of food (57). Wet site drainage will eliminate beavers from the area affected.

Snags and Down Logs

Downy Woodpecker

Downy woodpeckers represent the group of birds known as primary cavity-nesters, those species which excavate their own cavities for nesting and roosting. It is a bird of wide distribution which uses open woodlands, orchards, parks, and suburban areas (58, 59,60). Though often observed in conifers, it nests, roosts, and feeds primarily in young, medium-sized deciduous trees such as willow, cottonwood, and alder (58,60). This preference for hardwoods places it very often in riparian ecosystems. This woodpecker feeds mostly on insects, nests in holes in dead trees, and excavates new cavities each year near the top of a tree located in fairly open timber (59). Often the same tree will be used each year, however, old cavities are rarely used (59).

Nest holes range from 8 feet to 50 feet high in the tree and average 1.2 to 1.4 inches in diameter (59). New cavities are excavated each fall, to be used as winter roosts (59). Although downy woodpeckers forage in open areas, they are unlikely to nest or roost there until the stand grows back into a young forest.

Forest practices often change the number of snags within riparian ecosystems. During road construction, thinning, harvest, and site preparation, snags are cut, knocked over, or burned, resulting in a reduction in the size and number of snags. Alternately, practices such as herbicide treatment of unmerchantable trees and slash burning, which may encroach upon adjacent stands, create some new snags of various ages. The number of snags lost in intensive forest management is believed to be greater than the number gained.

The loss of snags reduces or eliminates nesting, denning, and perching habitat and food (e.g. insects) for the downy woodpecker and leads to a decline in abundance of such snag-dependent species. Snags which survive forest management practices intact or reduced in height may continue to be used by wildlife, but may be used differently, wildlife using snags in a forested condition may give way to cavity-nesting species which use snags in open conditions; species requiring cavities high in snags may be eliminated, leaving those animals which use shorter snags. This results in temporary changes in the composition and abundance of species inhabiting an area, and may produce permanent losses of species restricted to the oldest forest stands which will not develop in the short rotation schemes now used on intensively managed forest lands.

Wood Duck

Wood ducks are one of a large family known as secondary cavity-nesters; birds and mammals which nest or den in natural cavities or those created by other species. Wood ducks prefer slower -moving backwaters and sloughs or rivers, ponds and lakes where there are open woodlands with deciduous trees such as cottonwoods and willows and dense cover along the bank edges (58,59,60). Open woodlands are preferred over dense stands, but streamside conditions must include suitable cover and brood -rearing areas (61). Overhanging tree branches, flooded or low-growing shrubs, slow-moving water, and a supply of insects and duckweed often fulfill these requirements (61). It is a bird completely dependent upon the riparian ecosystem, its use spanning the entire year. It feeds on insects, vegetation, seeds, and fleshy fruits, and nests in large trees usually not far from water (58,59). Nesting cavities are usually located in dying or dead deciduous trees at least

24 inches in diameter (59). Because wood ducks are limited primarily to riparian ecosystems, forest practices which affect the number and distribution of snags in these areas will have a great impact on them. Reducing the number of snags will reduce the number of wood ducks immediately, and the loss may be permanent if succeeding trees are not allowed to grow to suitable size. Leaving snags during clearcut logging will temporarily reduce cavity use by ducks. As the stand matures, suitable cavities may again be used, provided other requirements of cover and food are met. However, most forest practices which affect snags in riparian ecosystems have significant, long-term negative impacts on wood ducks.

Raccoons

Raccoons are found in timbered or brushy areas throughout the state, most often in the lowlands near streams, marshes, ponds, and ocean beaches (43,44). They forage largely along water and eat a wide variety of food, including crayfish, fish, amphibians, eggs, insects, and fruits (44,62). Although they often rest in trees or on the ground, raccoons use dens in hollow trees, banks, or rock crevices to house their cubs and to spend the late fall and winter (43,44). In western Oregon, resting sites are found in hollow snags with entrances to the dens ranging from 4 to 36 feet above the ground (43). Forest practices which reduce snags in riparian ecosystems will be likely to reduce the number of raccoons. If the stand is removed, exposed snags will not be used until the area grows up into brush again.

Down Woody Material

Ruffed Grouse

Dead and down woody material serves many important functions, one of which is wildlife habitat (63). The lack of down woody material in riparian ecosystems affects wildlife in various ways. Male ruffed grouse "drum" on hollow logs to attract females as part of their breeding display. The logs selected by the males are usually large, and often the same log is used for many years by succeeding males (64).

The reduction or elimination of down logs through road and landing construction, slash burning, scarification, and firewood cutting forces ruffed grouse to seek secondary drumming sites. The lack of suitable secondary sites may reduce the productivity of ruffed grouse in that area.

Black Bear

Black bear use down woody material as dens and sources of food. Bees, ants, and termites are frequent food items in spring and early summer (65). Hollow logs are sometimes used as winter dens (62).

Forest practices which reduce or eliminate down woody material will reduce food sources and potential den sites of black bear.

Salamanders

Salamanders require moist environments, such as those found under down woody material, for feeding and resting. An example is the western red-backed salamander, whose preferred habitat is decaying logs and moss-covered rock rubble. It lays its eggs in clusters in damp areas such as decaying logs, and feeds on termites and other soft-bodied insects also commonly found in these logs (66).

Reduction or elimination of down woody material will lead to a direct reduction or elimination of salamanders because of their dependency on this habitat.

In the Blue Mountains, 179 species of vertebrates (5 amphibians, 9 reptiles, 116 birds, and 49 mammals) make some use of logs (63).

Existing large down material (logs) is reduced or eliminated by road and landing construction, slash burning, scarification, and firewood cutting. Existing trees, which would naturally form larger down woody material in the future, are eliminated by road and landing construction, timber harvest, salvage logging, commercial thinning, and timber type conversion. Use of short rotations will reduce or eliminate the source of large down woody material.

Travel Lanes

Riparian zones along intermittent and permanent streams and rivers provide migration routes for birds, bats, deer, elk and other wildlife (67). Their distribution in long corridors provides protective pathways for migrations and movements between habitats (68). This is particularly true in the drier forests of eastern Washington where the fingers of riparian vegeta- tion extending down from the mountains sometimes form the only cover available for protection. It is also true in western Washington where many species use them as travel corridors in moving from one area to another (47,69). Game trails interconnect through the dense vegetation allowing wildlife to travel in safety.

White-tailed Deer

White-tailed deer are good examples of this important function of riparian areas because they are found primarily in dense forests, deciduous woods, and extensively brushy areas near water (44,62). The forest practices which most affect white-tailed deer travel along watercourses are road and landing construction and use, timber harvest, thinning, sanitation cutting, and timber type conversion. All of these practices temporarily reduce or eliminate the vegetation on which deer depend for cover during travel.

Mink

Mink occur mostly near water, where their diet of fish, frogs, muskrats, and other aquatic animals is available (44). Mink spend much of their time in water, but travel and forage extensively on land, especially in winter (44). Elimination of the riparian cover reduces the populations of the animals on which mink prey, and exposes mink to larger predators while traveling or foraging. This directly reduces the number of mink in the areas where riparian cover has been removed. The forest practices most responsible for this effect are road and landing construction, timber harvest, and timber type conversion.

Disturbance and Harassment

Disturbance and harassment of wildlife by humans is more critical in riparian ecosystems because of their importance relative to upland forests. For some species the importance of riparian ecosystems is as breeding habitat, for others wintering habitat, and for others feeding habitat.

Elk

Perry and Overly (70) found that use of habitat by elk in the semi-open habitats of the Blue Mountains was greatly reduced for over one-half mile on either side of roads; use by deer was affected to a lesser extent, but was much reduced up to one-eighth mile from roads. This disturbance can affect calving and fawning, feeding, resting, and wintering areas of elk and deer and force them to search for more isolated areas, which are less suitable habitat. All users of forest roads, including traffic associated with forest management, and especially recreational users, disturb elk and influence their use of habitat.

Raptors

Snags and broken-topped trees are used for nesting and perching by large birds of prey such as eagles and ospreys (71). Nest sites are usually over water or not far from water (64). The size of the birds and their nests makes them easily discovered by humans and, thus, open to disturbance.

Noise from roads, timber harvest, and logging equipment can reduce nesting success by continually forcing incubating adults from active nests.

Snowshoe Hare

Snowshoe hares are an example of the small mammals, amphibians, birds, and some large mammals which are directly killed or injured by logging trucks and other traffic on logging roads. When these roads cross riparian ecosystems the impact can be greater because wildlife populations are greater in those areas.

POTENTIAL CHANGES IN RIPARIAN HABITAT - FISH

The Fish Subcommittee identified 8 separate categories of potential change within the riparian ecosystem which could result from forest practices. Some of them pose significant long term threats to fish production, others are short term and not widespread. Other types of changes may be significant, such as energy cycling, but have not been well quantified at this time (Matrix 17).

Alteration of Shape and Structure of Stream Channel Due to Loss of Sources of Instream Woody Debris

Stable woody debris in the channel regulates stream velocity and depth, moderates the effective gradient, dissipates energy, retains organic matter for processing, stores spawning gravels, and creates and maintains pools riffles, backwaters and side-channels (72,5,73,74). Under current forest practices regulations there are no requirements to directly provide for the source of woody debris for streams. Although a stream many have a good complement of woody debris prior to and after harvesting, future sources of woody debris may be lost with the trend toward short rotation ages (75,76). This would not become a problem until the existing debris completely decays or is transported out of the stream. The stream will then become more unstable and effectively steeper in gradient. Such changes in channel structure can lead to a widespread significant long-term change in fish population composition and loss of overall fish productivity (90). Downstream erosion and sedimentation may also result from channel changes caused by the lack of woody debris.

The loss of sources of woody debris is further exacerbated (especially in Type 4 & 5 waters) because existing debris is destabilized as a result of tree felling and yarding in the stream (77,78). In many cases the fine branches and needles are not completely removed when a stream is cleaned and can lead to matting of this material against larger unstable debris resulting in dramatic shifts of the debris (79). On the other extreme the channel may be overcleaned or salvage logged which accelerate the instability that may result from natural decay without replacement (80).

TABLE 15. LIST OF FOREST PRACTICES WHICH MAY ALTER RIPARIAN ECOSYSTEMS (RE)

A. ROAD AND LANDING CONSTRUCTION

1. Planning, Design and Location
2. Construction
   a. stream crossings
3. Use
4. Maintenance
5. Abandonment

B. TIMBER HARVEST

1. Harvest Unit Layout - Yarding System - Timing - Volume/Area Involved -
2. Rotation Age
3. Removal of Vegetation from RE
4. Felling Timber Directly into Water
5. Skidding and Yarding over or through Water
6. Felling and Yarding on Steep Slopes Above Water
7. Stream Cleanout of Recent Logging Debris
8. Salvage Logging

C. SITE PREPARATION AND FUELS MANAGEMENT

1. Slash Burning
   a. with prior treatment with dessicants
   b. fire trails
2. Scarification
3. Wet Site Drainage
4. Secondary Harvest Activities to Reduce Fuels Loading (i.e. firewood)

D. TIMBER STAND IMPROVEMENT

1. Fertilization
2. Pesticide Application
   a. herbicides
   b. insecticides and rodenticides
3. Thinning
   a. pre-commercial
   b. commercial
4. Sanitation Cutting (e.g. diseased tree removal)
5. Timber Type Conversion

Note: Cumulative effects occurring in Riparian Ecosystems is an issue identified for further consideration. The FP Board has commissioned a study specifically to address cumulative effects. The scope of this study involves all forest land and all physical and biological elements of the environment.

MATRIX 17. POTENTIAL CHANGE IN RIPARIAN ECOSYSTEM - SOURCES, EFFECTS, SIGNIFICANCE TO FISH

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effect on Fish	Significance of Change
Alteration of shape and structure of stream channel due to loss of instream woody debris	B. Timber Harvest 1. Harvest unit layout 2. Rotation age 3. Removal of vegetation 4. In RE felling timber directly into water 5. Skidding & yarding over or through water 6. Felling & yarding on steep slopes above water 7. Stream cleanout of recent logging debris 8. Salvage logging	B.1 Unit layout dictates yarding system or visa/versa. Unit layout dictates suspension yarding vs. highlead. Stream involvement varies with layout. B.2 Rotation age dictates size of trees in RE which may become instream debris (i.e. young trees less likely to fall). B.3 Removal of trees in RE precludes introduction of woody debris into stream. B.4, 5, 6 Felling trees and yarding timber introduces slash and debris which in never completely removed, also felling and yarding destabilizes existing downed woody debris. B. 7 & 8 Overzealous cleanout or salvage destabilizes existing woody debris.	B.1-5,7,8 Effect is usually indirect (i.e. habitat quality) removal or de-destabilization of woody debris results in alteration of physical and biological characteristics of a stream. Stable woody debris stream velocity, depth, moderates local gradient, dissipates stream energy, creates and maintains pools, riffles, backwaters, and side channels, and affects stream nutrient processing. Fish effects are reduced. Yield of seaward and resident trout, increased abundance of trout fry, decrease of spawning habitat.	B.1-5,7,8 The loss of woody debris will result in a significant long-term reduction in the number of chinook, coho, and sockeye salmon and adult trout. The magnitude of change is related to the number and ages and size of trees left in RE, length and size of stream residual supply of stable instream woody debris.
Alteration of stream channel shape and stability, streamside vegetation and water quality due to mass soil movements.	A. Road & Landing Cons- 1. Planning, design, location 2. Construction 3. Maintenance 4. Abandonment	A.1 Road layout and design are significant factors influencing future failure (i.e. road across unstable slopes, steep slopes, wet areas and insufficient drainage). A.2 Side casting over steep slopes, construction not according to design (i.e. loggers choice, culvert spaceing). A.4 & 5 Maintenance may reduce but not eliminate possibility of failure on high risk roads. B.1-5, 7, 8 Build-up of logging slash, destabilization of logging debris during yarding increases probability of mass movement and contributes to severity of failure when it occurs, slope failure on non-roaded area may occur due to stump weight as root strength is lost.	A.1-5, B.1-5, 7, 8 Severe habitat alteration and displacement or mortality of spawning or rearing fish and incubating eggs. Near total loss of habitat when mass slope failure enters stream as debris torrent. Stream often scoured to bedrock, scoured out debris may cause migration block in receiving stream.	A.1-5 Mass soil movements result in significant long-term loss of fish production in scoured area, loss of production in anadromous fish if stream blockage persists, increased stream energy in affected area, loss of nutrient processing due to high flushing rate, duration of loss. Production in area affected by sedimentation depends upon stabilization of sediment source and stream's flushing ability. Frequency of mass wasting related to geology, slope steepness, drainage and storm events, magnitude of change related to frequency of occurrence, volume of slide materials, length of stream affected and level of fish use.

AV/W16(A2,4-7)

MATRIX 17. POTENTIAL CHANGE IN RIPARIAN ECOSYSTEM - SOURCES, EFFECTS, SIGNIFICANCE TO FISH

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effect on Fish	Significance of Change
Alteration of fish habitat from increased fine sediment in water and within streambed due to surface erosion and instream construction.	A. Road and Landing Construction 1. Planning design and location 2. Construction 3. Use 4. Maintenance 5. Abandonment	A.1-5 Increased introduction of sediments into a stream, lake, or pond begins with the first instream construction or after the first rain due to exposed soils on cutbanks, fills, and ditches, erosion of the grade during road use, erosion on pioneered roads, working in inclement weather, failure to stabilize prior to rainy season.	A.1-5 Decrease in fish production due to lowered egg survivla reduced ovewinter survival and reduced aquatic insect production. Chronic high levels of suspended solids may cause fish avoidance and underutilization of spawning rearing areas.	A.1-5 A widespread problem that can be of relatively short duration if sediemnt source is controlled and flushing rate is rapid.
Alteration of water temperature regime due to removal of streamside vegetation and slash burning.	B. Timber Harvest 3. Removal of vegetation in RE 8. Salvage logging. C. Site Preparation and Fuels Management 1. Slash burning 4. Secondary harvest D. Timber Stand Improvement 3. Thinning a. Precommercial b. Commercial	B.3,4, D.3, C.4 Removal of streamside vegetation results in changes in water temperature (usually increased) due to increaed sun exposure. C.1 Direct heating of the water may occur during slash burns.	B.3,4, C.4, D.3 Extreme variations in water temperature are harmful, fish become stressed, more prone to disease, migration may be delayed, egg incubation accelerated, emergence timing altered, slight variations may be beneficial becasue of increased summer growth. Freezing and/or drying of incubating eggs may occur in colder areas where insulating canopy is removed. C.1 Mortalities can result if stream temperature becomes excessive.	The significance of this problem has regional variation. The magnitude of change is related to amount of shade removal, stream size, aspect, elevation, topography, and rate of regrowth of shade-producing vegetation. A short-term situation when it occurs.
Alteration of fish passage and aquatic habitat at stream crossilngs or where road parallels stream in RE.	A. Road and Landing Construction 1. Planning design and location 2. Maintenance	A.1 Road layout dictates numbers and location of stream crossings encroachment in RE design for cost and efficiency not always compatible with needs of fish. Some culverts and bridges restrict or prevent juvenile or adult passage because of excessive velocity, shallow depth, outfall drop. A.4 Bank protection may be required where road or bridge is jeopardized by stream. Rip-rap installedto protect road prevents formation of cutbank or buries existing habitat. Occasionally, debris is removed, gravel excavated, channel diverted to relieve symptoms.	A.1 Poor distribution of spawners and juveniles results in reduced numbers of seaward migrants and in some cases resident trout. A.4 Loss of spawning/rearing habitat due to poor burying, channel scour causing egg loss, loss of vegetative cover and instream debris diminished flood plain width.	A.1, 4 A very serious problem when it exists. Usually prevented or mitigated through other laws, magnitude related to location and design and number of crossings or frequency of channel encroachment.

AV/W16(A2,(8-11)

MATRIX 17. POTENTIAL CHANGE IN RIPARIAN ECOSYSTEM - SOURCES, EFFECTS, SIGNIFICANCE TO FISH

Potential Change in Riparian Ecosystem (RE)	Forest Practice(s) Causing Change	How Change Occurs	Effect on Fish	Significance of Change
Increased use of RE by humans due to increased access	A. Road and Landing Construction 1. Planning, location, design 2. Use	A.1, 3 Roadss are built which allows vehucular access into previously unroaded areas.	A.1, 3 Increased harvest or harassment/ disturbance especially adult salmon and steelhead	Probably widespread. Significance varies with proximity to population and fish use, road density
Alteration of aquatic productivity due to increased solar radiation	B. Timber Harvest 3. Removal of vegetation in RE 4. Felling timber directly into water 5. Skidding or yarding over or through water 7. Stream cleanout recent debris 8. Salvage logging C. Site Preparation and Fuels Management 1. Slash burning 4. Secondary harvest D. Timber Stand Improvement 3. Thinning 4. Sanitation cutting 5. Timber type conversion	B, C, D Removal of vegetation increases solar input to water stimulating primary production of aquatic system. Corresponding increase in aquatic insects and fish.	B, C, D Increased growth through increased food supply	Properly controlled (i.e. maintenance of stream structure, sediment and temperature) could result in significant increase in fish production.
Alteration of Terrestrial energy base due to removal of streamside vegetation	B. Timber Harvest 3. Removal of vegetation in RE C. Site Preparation 1. Slash burning in RE 4. Secondary harvest	B, C Leaf litter is source of energy to stream, lost when vegetation removed, terrestrial insect drop-off may be reduced until low brush reestablished.	Not well understood	Unknown at this point.

AV/W16(A3,12-15)

The significance of these potential changes is dependent upon the fish use within and below the unit (81,75,82), the unit layout (83), the intensity of logging (84), the residual debris source, and the length, size and gradient of the stream. For example, coho salmon and steelhead in the upper reaches of a steep gradient stream will be impacted to a greater extent than chinook salmon in a larger lower gradient stream. Chum salmon would be affected less than chinook or coho. Cutthroat trout which inhabit small steep gradient streams would also be adversely affected (85,86).

Alteration of Stream Channel Shape and Stability, Streamside Vegetation, and Water Quality Due to Mass Soil Movements

Perhaps the most dramatic change of forest practices upon streams results from slope failures - or mass soil movements. This can be either on the open slope or within the stream channel (76). Slope failures occur naturally, however, in logged forest lands slope failures are usually more frequent and travel farther (83). They are usually associated with roads but failures also occur in harvested areas (87). Road layout, design and construction are significant factors which influence the potential for future failures (88). For example, mid-slope roads are more prone to failure than ridge top roads, because sidecast material may become saturated and fail in-mass. Some of these occurrences may be reduced or prevented through timely maintenance; but slope failures cannot be eliminated, especially in steep unstable terrain.

Mass failures may also occur as a result of timber harvest. As mentioned in the discussion of woody debris, felling timber into streams or over-cleaning may destabilize existing woody debris. The result may be a stream scoured to bedrock with all the debris, soil, and gravel deposited in a lower gradient fish bearing water. This kind of failure causes obvious severe habitat degradation and displacement or mortality of spawning and/or rearing fish and incubating eggs. Fish population recovery from such occurrences may be slow or incomplete (89). Other impacts could include the creation of migration barriers to anadromous fish, increased stream velocities, pool filling in downstream areas and reduced organic matter processing time (82). In some cases debris torrents can deliver organic debris and gravels to stream reaches which lack structure. This could be true for streams which have been harmed by past poor practices (90).

Again the significance of these potential changes depends upon fish use within and below the area impacted, stabilization of the slope, and the flushing ability of the stream (91,92). The frequency of mass movements depends upon local geology, slope steepness, extent of roading, drainage, and intensity and duration of storm events (94,95). The magnitude of change is related to the volume of slide materials, frequency of slides, and stream size and length (96,97).

Alteration of Fish Habitat From Increased Fine Sediment in the Water and Streambed Due to Surface Erosion, Installation of Stream Crossings and Other Instream Construction

Increased fine sediment within the water column and especially within the streambed reduces fish production because of lowered egg survival (91,92), lowered over-wintering survival (98), and lower aquatic insect production (99). Chronic high levels of suspended sediments may cause avoidance and under utilization of spawning or rearing areas, reduced feeding ability of juvenile salmonids (25,100,101,102).

Sedimentation of streams and lakes results from road and landing construction, use, maintenance and abandonment (25,100,101,102,103). Increased introduction of sediments begins with instream construction or after the first rain due to exposure of road surfaces, cutbanks, fills, and ditches. Erosion of the road surface during hauling may contribute significant amounts of sediment to streams (103, 104,105,106). Also improperly stabilized "pioneer roads" and road grading during inclement weather may result in excessive levels of sedimentation (104).

Sedimentation of this nature is believed to be a widespread problem of relatively short duration. Main haul roads, however, present an exception because the problem can persist for years. The significance of the problem depends upon control of the sediment source and rate of flushing from the channel (84).

Alteration of Water Temperature Regime Due to Removal of Streamside Vegetation and Slash Burning

Extreme variations of water temperature are harmful to fish. They become stressed, more prone to disease, migration may be delayed and incubation may be accelerated which alters emergence timing (107). Under the most extreme situations, mortalities may result (108). Slight warmings, however, may be beneficial resulting in increased growth of fish (22,109,110). The benefits of opening the canopy will occur if all other aspects of the habitat remain essentially unchanged and usually last 10-15 years until the stream is again shaded.

Water temperature variations are obviously related to canopy removal (i.e. tree felling and disturbance of understory brush shading the water surface). This results in direct exposure of the stream to sunlight (111,112).

Slash burning, in extreme cases may raise water temperatures to lethal levels for fish (113). In some instances streamside vegetation is destroyed.

The significance of this potential impact can vary regionally. The magnitude and duration of impact is related to amount of shade removed, stream size, aspect, elevation, topography and rate of regrowth of shade vegetation. Members of the Fisheries Subcommittee felt that this situation tended to be short term, and is usually controlled by proper administration of existing forest practices regulations.

<u>Alteration of Fish Passage and Aquatic Habitat at Stream Crossings or Where Roads Parallel Streams In or Adjacent to the Riparian Ecosystem</u>

Both adult and juvenile salmonids require unobstructed upstream and downstream passage at different stages of their life history. The presence of migration barriers may eliminate or severely limit fish populations. For example, coho salmon populations can become suppressed if access to spawning gravels is blocked, even though adequate amounts of rearing habitat are available. Another example of the impact of a migration barrier would be when access to an overwintering pond or tributary is lost. In this case, juvenile coho may not survive winter freshets (41, 42). Additionally, in the case of chum and pink salmon which have a very limited freshwater rearing residence, access to spawning gravels is critical. Also, if salmon are forced to spawn under unsuitable, overcrowded conditions, super-imposition often occurs. Super-imposition is digging up of an existing nest, resulting in reduced egg survival. Crowding of spawning salmon will often force fish into less satisfactory habitat, with resultant low survival of spawners and eggs (114).

Road layout dictates the number and location of stream crossings. Often the initial cost and efficiency of operation of a culvert is not compatible with acceptable fish passage. As a result, passage is reduced or eliminated because of excessive flow velocities, excessive jump height due to improper culvert placement or scour at culvert outlets, and inadequate depths and lengths within a culvert. At times bridges can impede passage due to inadequate footing width (32).

Culvert blockage is a serious problem when it develops however, it is not believed to be widespread on forest lands. The magnitude of the problem is related to road density, inadequate road design, and lack of compliance with existing laws.

Loss of spawning or rearing habitat may also occur when roads encroach onto stream margins and when stream channel erosion creates a need for bank protection (115). Placement of rock rip-rap may bury pools, cause channel scour and streambank erosion within the vicinity of the rip-rap. In addition, streambank vegetation is often lost and instream debris may be removed, in an effort to minimize streambank cutting. This situation may be serious locally, but is not believed to be widespread.

Increased Use of Riparian Ecosystems Because of Increased Human Access

Increased access into previously undisturbed areas may lead to disturbance or harassment of adult salmon and trout especially at road crossings. Also suspected would be increased fishing pressure legal or not. These activities are suspected to be problems, although they have not been formally documented. The seriousness of any problems will vary with proximity of the area to population centers, road density and the level of fish use. Spring chinook and summer steelhead adults would be particularly vulnerable because of their extended pre-spawning residence in streams during low, clear water periods.

Alteration of Aquatic Productivity Due to Increased Available Sunlight

Removal of shading vegetation increases solar input to a stream resulting in an increase of algal growth on a stream bottom. Murphy, et al. (116) reported additional instream production of algae may lead to increased fish food production and ultimately to increased fish growth. De Leew (109) further states that water temperature increases may increase the ability of fish to metabolize food more efficiently resulting in faster growth. This can occur even when the amount of fish food remains unchanged from shaded conditions.

When shade removal is controlled such that stream temperature fluctuations are moderate, and other independent stream habitat elements are unchanged, increases in salmonid production can be expected (117,118). However, if the structural stability of a stream is lost (22), the benefits of increased solar radiation may be temporary or negligible.

Alteration of Terrestrial Energy Base Due to Removal of Streamside Vegetation

Organic litter (leaves and needles) is lost as a source of energy to a stream after canopy removal and understory disturbance. In addition, terrestrial insects may be temporarily lost as a food source if the vegetation is slow to recover. However, the temporary loss of streambank energy sources may be replaced, wholly or in part, by aquatic production. Also, as stated previously, retention time of litter is reduced in the absence of retention dams created by large woody debris. These issues are not well quantified and their significance is unknown at this time.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

Conclusions and recommendations of a general nature are presented in the initial sections of this chapter. Wildlife issues are separated from fisheries issues.

Specific conclusions and recommendations follow those of a general nature. These are organized by major "Potential Change" category as presented in the left margin of Matrices 16 and 17 (Chapter 4).

In general, these conclusions and recommendations represent the consensus of the Riparian Habitat Technical Committee. In some instances, however, full consensus was not achieved. When this occurred, dissenters were asked to prepare position statements to describe differences of interpretation and to provide supporting evidence. Position statements are contained in a separate section at the end of this report.

GENERAL CONCLUSIONS AND RECOMMENDATIONS - WILDLIFE

Riparian ecosystems contain the most important wildlife habitats in Washington's forests. "Riparian habitat is an extremely critical and unique type. Riparian makes up the smallest percentage in land area of the habitat types, yet it is the most important habitat to wildlife whether it is in the Coast Ranges or on the desert" (34).

Forest practices which create large openings and induce accelerated succession provide short-term benefits for some wildlife in the riparian community, particularly those favoring early successional stages. Negative impacts include; (a) permanent changes in wildlife community composition under short-rotations or management which emphasizes conifers, (b) a reduction in those species using older forest stands which do not develop under short rotations, and (c) changes in patterns of wildlife use in riparian ecosystems following the construction and use of roads.

Optimum conditions for many wildlife species can be found where a mixture of mature and over-mature forest and other forest successional stages occur in close proximity to riparian ecosystems. However, naturally-evolved riparian systems contain a complex mix of vegetation where several edges and vertical and horizontal vegetative layers occur. Both mature and young trees and standing and down dead trees occur with natural openings interspersed. The wildlife sub-committee concludes that optimum conditions for the majority of wildlife within riparian ecosystems are found in unmanaged mature or over-mature forests.

This sub-committee recognizes that riparian habitat has been and may continue to be managed for purposes of timber production and recommends that forest practices be examined to determine those most compatible with maintaining the viability of all wildlife species. We recommend that an interim planning process, such as the Washington Department of Natural Resources Sensitive Area Planning Process, be applied to applications for timber harvest in riparian ecosystems at least until a Phase II study is completed.

GENERAL CONCLUSIONS AND RECOMMENDATIONS - FISH

Fish species diversity and population size is dependent upon habitat quality within the riparian ecosystem.

The role riparian vegetation plays in shaping and maintaining fish habitat depends upon the successional stage and composition of bank vegetation, stream size and gradient and lake or pond size, shape and volume. Generally, fish habitat is most well provided for in mature or old growth successional stages.

Forest practices can potentially change the quality of riparian ecosystems. The change may be short or long term and may be positive or negative. Changes occur through alteration of: stream shape, structure and stability; water quality; fish passage; access to human activities; and, inputs of organic matter.

It is recommended that current Forest Practices policies and methods relating to riparian ecosystems be reexamined to ensure maintenance and perpetuation of good quality fish habitat.

SPECIFIC CONCLUSIONS AND RECOMMENDATIONS - WILDLIFE

Food and Cover

Conclusions:

- Under short rotations, there is a permanent change in wildlife species composition and a reduction in those which use older forest stands for feeding and/or cover.

- When cover is reduced or removed, animals are exposed to increased predation, poaching and environmental stress.

- Wildlife species composition is permanently changed and some species are eliminated when the timber type is converted from hardwood or mixed to conifer-dominated stands.

Recommendations for Phase II:

- That alternative methods and a policy be recommended to the Forest Practices Board which provide adequate protection for riparian habitat on State and Private lands.

- That identification be made of those wildlife species most impacted by various rotation lengths or treatments which emphasize conifer production.

- That a determination be made of the effects on wildlife numbers and species of several successional stage mixes; determination of the range of conditions that provide suitable habitat for species impacted under current conditions.

- That a determination be made of the changes in the wildlife community if current forest practices are continued.

Snags and Down Woody Material

Conclusions:

- Under short rotations, with removal of snags and down logs, there is a permanent reduction in abundance of some wildlife; other species which use these habitats are eliminated.

Recommendations for Phase II:

- That methods and a policy be recommended to the Forest Practices Board to meet the needs of wildlife dependent upon large snags and down logs.

- That silvicultural systems, treatments, and logging plans be identified which provide opportunities for retaining snags and down logs.

- That a determination be made of the appropriate numbers and sizes of snags and down logs to provide for populations of dependent wildlife.

- That an evaluation be made of the need for large, standing green trees to provide for recruitment of snags and down logs in the future.

Disturbance and Harassment; Travel

Conclusions:

- The presence of actively used roads in riparian ecosystems causes increased disturbance and harassment to wildlife and interferes with normal use of habitats.

- Direct and indirect mortality are increased as a result of traffic and increased human activity.

Recommendations for Phase II:

- That a recommendation be made to the Forest Practices Board for a policy concerning road placement and management that insures use of habitat by wildlife.

- That a determination be made of the effects on wildlife of various road density levels.

- That alternatives be developed for road placement and that such alternatives be ranked by preference.

- That guidelines be developed for management of existing roads for the purpose of minimizing disturbance to wildlife.

SPECIFIC CONCLUSIONS AND RECOMMENDATIONS - FISH

Stream Channel Shape and Structure

Conclusions:

- Sources of large woody debris for stream courses are not provided for under current forest management systems. This, in combination with an emphasis on short rotations, will result in significant long-term reductions in fish habitat quality and eventually in fish populations or in species composition as residual instream debris deteriorates.

- Mass slope failures have the potential to significantly impact fish habitats and populations.

- Roads which cross or are aligned parallel to streams can unnecessarily encroach upon fish habitat and/or fish passage to important spawning or rearing habitats.

Recommendations for Phase II:

- Develop recommendations for the Forest Practices Board for methods to provide for proper organic debris loading in streams, lakes and ponds. These methods should address residual time lag of existing debris, where organic debris is necessary, desirable rates of recruitment; and, how to provide the equivalent of large organic debris in large streams.

- Develop recommendations for the Forest Practices Board for methods to further reduce the likelihood of mass failures and their impact upon streams, lakes and ponds.

- Develop recommendations for the Forest Practices Board for methods to further eliminate road encroachment and/or construction impacts in riparian ecosystems.

Water Quality

Conclusions:

- Under current State forest practices regulations, water temperature problems are felt to be regional and of short duration when they occur. Moderate increases in water temperatures have been shown to be beneficial to summer growth for some salmonid species.

- Suspended sediment and streambed sedimentation from road construction, use and maintenance has been found to reduce fish production. Stream sedimentation continues to be a widespread concern in forest lands. The duration of the problem depends upon control of the sediment source and the flushing ability of the stream.

- Mass soil failures in forest lands contribute significant amounts of sediment to streams, lakes and ponds.

Recommendations for Phase II:

- Develop recommendations for the Forest Practices Board for methods to further diminish sedimentation of streams, lakes and ponds.

- Continue to ensure compliance with existing temperature control regulations.

Productivity of Aquatic Ecosystems

Conclusions:

- Controlled removal of vegetation in the riparian ecosystem can result in measurable increases in fish production through increases in fish metabolism and in food supply. However, increased solar radiation may be a temporary or negligible benefit if structure and stability of the channel is lost.

- Aquatic nutrient availability is altered after removal of riparian sources of woody debris, may also reduce leaf litter retention.

Recommendations for Phase II:

- Recommend to the Forest Practices Board methods to provide selective removal of riparian vegetation during timber harvest.

- Develop further information regarding nutrient processing in forest streams.

Harassment and Increased Fishing Pressure by Humans

Conclusions:

- Fish harassment and fishing pressure may be a problem on forest lands because of increased road access to spawning and rearing refuges.

Recommendations for Phase II:

- Further identify the magnitude and occurrence of this problem. If necessary, propose methods of control to the Forest Practices Board.

GLOSSARY

ABUNDANCE - The total number of individual animals of a particular species living within a given area.

AQUATIC ZONE - The area below the mean annual high water mark of surface waters including the water, banks, beds, organic and inorganic constituents.

CARRYING CAPACITY (FISH) - The greatest weight of fishes that a stream can naturally support during the period of least available habitat, typically summer low flow (Burns (26)).

CARRYING CAPACITY (WILDLIFE) - The maximum rate of animal stocking possible without inducing damage to vegetation or related resources; may vary from year to year because of fluctuating forage production (Thomas (18)).

COMMUNITY - A group of one or more populations of plants and animals in a common spatial arrangement, indicative of plants and animals which have adapted to given site conditions (after Thomas (18)).

DIVERSITY - The relative degree of the abundance of wildlife species, fish species, plant species, communities, habitats, or habitat features per unit area (after Thomas (18)).

DIRECT INFLUENCE ZONE - The area outside, but adjacent to a riparian zone which includes trees which shade a stream or directly contribute coarse or fine woody debris or terrestrial insects to aa stream (after Meehan et al. (4)).

EDGE - The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together (Thomas (18)).

GRASS-FORB SUCCESSIONAL STAGE - Shrubs and/or tree regeneration less than 40 percent crown cover and less than 5 feet in height; may range from largely devoid of vegetation to dominance by herbaceous species - grasses and forbs (Hall et al. (93)).

HABITAT - The sum total of environmental conditions of a specific place occupied by fish or wildlife species or populations of such species. Such environmental conditions are used to satisfy one or more life cycle requirements of a species.

MATURE FOREST SUCCESSIONAL STAGE - A stand with average diameters exceeding 21 inches d.b.h.; crown cover may be less than 100 percent; little decay or defect present; minimal occurrence of understory trees; dead and down material residual from previous stand (Hall et al. (93)).

OLD-GROWTH SUCCESSIONAL STAGE - Stands with at least two tree layers (overstory and understory); at least 20 percent of the overstory layer composed of long-lived successional species; standing dead and down material; decay in some trees; and average diameters of overstory trees greater than 21 inches d.b.h. (Hall et al. (93)).

POLE-SAPLING DOMINATED SUCCESSIONAL STAGE - Average stand diameter greater than 1 inch d.b.h. and tree crown canopy less than 60 percent; saplings are 1-4 inches d.b.h.; poles are 4-9 inches d.b.h..

RIPARIAN ZONE - The are bordering streams, lakes, tidewaters, and other bodies of water, characterized by a high water table, and may contain plants which require saturated soils during all or part of the year; riparian zones are the transitional areas between aquatic and terrestrial environments.

RIPARIAN ECOSYSTEM - An interacting natural system including, and adjacent to surface waters; including all the organic and inorganic elements contained in an aquatic zone, riparian zone, and direct influence zone. The total of all environmental elements that directly contribute to the structural and functional processes of a body of water.

SHRUB DOMINATED SUCCESSIONAL STAGE - Shrubs greater than 40 percent of crown canopy; they can be any height; trees less than 40 percent crown canopy with small stem diameter (Hall et al. (93)).

SITE CLASS - A measure of the relative productive capacity of a forest site based on volume or height of the trees or the maximum mean annual increment that is attained or attainable at a given age (Davis (15)).

STOCKING DENSITY - A measure of the number or volume of trees growing in a given area; expressed as the percent of normal basal area or the number of stems per acre (Davis (15)).

STREAMSIDE MANAGEMENT ZONE - A specified area alongside natural waters where specific attention must be given to the measures that can be taken to protect water quality; 50 feet in width on each side of type 1 and 2 water, 25 feet in width on each side of type 3 water - as measured from the ordinary high-water mark (Ch. 222-16-010(48) WAC (2)).

STREAM ORDER - A method of classifying stream systems. First order streams are small, headwater segments with no tributaries. Second order streams begin at the confluence of two first order streams. The ordering system continues to higher order segments based upon the combination of two streams of the next lowest order (Strahler (8)).

WATER TYPE - A system for classifying water bodies contained in the Forest Practices Rules and Regulations. The five categories of water are based upon a combination of size, flow and uses of water (Ch. 222-16-020 WAC (2)).

YOUNG FOREST SUCCESSIONAL STAGE - Average stand diameters between 9 and 21 inches d.b.h. and tree crown canopy exceeding 60 percent (Hall et al. (93)).

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APPENDIX A

LIST OF WILDLIFE SPECIES OCCURRING IN WASHINGTON'S

FOREST RIPARIAN AREAS

BY SUCCESSIONAL STAGE

NOTE: THIS LIST OF WILDLIFE SPECIES IS ORGANIZED BY EVOLUTIONARY SCALE - OLDEST LIFE FORMS ARE LISTED FIRST FOLLOWED BY MORE RECENT LIFE FORMS. THIS IS THE METHOD THAT ANIMALS ARE USUALLY PRESENTED FOR IDENTIFICATION IN FIELD GUIDES.

FOREST RIPARIAN HABITAT STUDY

Presence of Wildlife in Riparian Ecosystems - By Successional Stages of Vegetation

SPECIES COMMON NAME	HERBACEOUS	HARDWOOD						CONIFEROUS					
		Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth	Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth
<u>MAMMALS</u>													
Opossum	X	X	X	X	X	X	X	X	X	X	X	X	X
Preble's Shrew	X	X	X	X	X	X		X	X	X	X	X	
Vagrant Shrew	X	X	X	X	X	X	X	X	X	X	X	X	X
Dusky Shrew	X	X	X	X	X	X	X	X	X	X	X	X	X
Pacific Water Shrew	X	X	X	X	X	X	X	X	X	X	X	X	X
Water Shrew	X												
Trowbridge's Shrew	X	X	X	X	X	X	X	X	X	X	X	X	X
Pygmy Shrew	X							X	X				X
Masked Shrew	X	X	X	X	X	X	X	X	X	X	X	X	X
Shrew - Mole	X	X	X	X	X	X	X	X	X	X	X	X	X
Yuma Myotis	X												
Keen's Myotis		X	X	X	X	X	X	X	X	X	X	X	X
Long-eared Myotis		X	X	X	X	X	X	X	X	X	X	X	X
Long-legged Myotis	X	X	X	X	X	X	X	X	X	X	X	X	X
California Myotis	X	X	X	X	X	X	X	X	X	X	X	X	X
Small-footed Myotis								X	X	X	X		
Silver-haired Bat	X	X	X	X	X	X	X	X	X	X	X	X	X
Big Brown Bat		X	X	X	X	X	X	X	X	X	X	X	X
Hoary Bat	X		X	X	X	X	X		X	X	X	X	X
Townsend's Big-eared Bat	X	X	X	X	X	X	X	X	X	X	X	X	X
Pallid Bat	X	X	X		X	X	X	X	X		X	X	X
Eastern Cottontail	X	X	X					X	X				
Nuttall's Cottontail	X	X	X					X	X				
Snowshoe Hare	X	X	X	X	X	X	X	X	X	X	X	X	X
Mountain Beaver	X	X	X	X	X	X	X	X	X	X	X	X	X
Least Chipmunk	X	X	X	X	X	X	X	X	X	X	X	X	X
Yellow-pine Chipmunk		X	X	X	X	X	X	X	X	X	X	X	X
Western Gray Squirrel				X	X	X	X			X	X	X	X
Red Squirrel					X	X	X				X	X	X
Douglas Squirrel										X	X	X	X
Northern Flying Squirrel					X	X	X				X	X	X
Northern Pocket Gopher	X												
Great Basin Pocket Mouse	X							X	X				
Beaver	X	X	X	X	X	X	X	X	X	X	X	X	X
Deer Mouse	X	X	X	X	X	X	X	X	X	X	X	X	X
Bushy-tailed Woodrat	X	X	X	X	X	X	X	X	X	X	X	X	X
Heather Vole	X	X	X		X	X		X	X		X	X	
Montane Vole	X	X	X					X	X				
Townsend's Vole	X	X	X	X				X	X	X			
Long-tailed Vole	X	X	X	X				X	X	X			

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FOREST RIPARIAN HABITAT STUDY (Continued)

Presence of Wildlife in Riparian Ecosystems - By Successional Stages of Vegetation

SPECIES COMMON NAME	HERBACEOUS	HARDWOOD						CONIFEROUS					
		Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth	Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth
Creeping Vole	X	X	X	X	X	X	X	X	X	X	X	X	X
Water Vole	X	X						X					
Southern Red-backed Vole	X	X	X	X	X	X	X	X	X	X	X	X	X
Northern Bog Lemming	X							X					
Muskrat	X	X											
Pacific Jumping Mouse	X	X	X	X	X	X		X	X	X	X	X	
Western Jumping Mouse	X	X						X					
Meadow Vole	X												
Porcupine	X	X	X	X	X	X	X	X	X	X	X	X	X
Nutria	X												
Coyote	X	X	X	X	X	X	X	X	X	X	X	X	X
Red Fox	X	X	X	X	X	X	X	X	X	X	X	X	X
Black Bear	X	X	X	X	X	X	X	X	X	X	X	X	X
Grizzly Bear	X	X	X	X	X	X	X	X	X	X	X	X	X
Raccoon	X	X	X	X	X	X	X	X	X	X	X	X	X
Marten	X			X	X	X	X			X	X	X	X
Fisher	X	X	X	X	X	X	X	X	X	X	X	X	X
Ermine	X	X	X	X	X	X	X	X	X	X	X	X	X
Long-tailed Weasel	X	X	X	X	X	X	X	X	X	X	X	X	X
Mink	X	X	X	X	X	X	X	X	X	X	X	X	X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X
Badger	X	X	X	X	X	X	X	X	X	X	X	X	X
Western Spotted Skunk	X	X	X	X				X	X	X			
Striped Skunk	X	X	X	X				X	X	X			
River Otter	X												
Mountain Lion	X	X	X	X	X	X	X	X	X	X	X	X	X
Lynx	X	X	X	X	X	X	X	X	X	X	X	X	X
Bobcat	X	X	X	X	X	X	X	X	X	X	X	X	X
Rocky Mountain Elk	X	X	X	X	X	X	X	X	X	X	X	X	X
Roosevelt Elk	X	X	X	X	X	X	X	X	X	X	X	X	X
Mule Deer	X	X	X	X	X	X	X	X	X	X	X	X	X
White-tailed Deer	X	X	X	X	X	X	X	X	X	X	X	X	X
Columbian White-tailed Deer	X	X	X	X	X	X	X	X	X	X	X	X	X
Moose	X	X	X	X	X	X	X	X	X	X	X	X	X

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FOREST RIPARIAN HABITAT STUDY (Continued)

Presence of Wildlife in Riparian Ecosystems - By Successional Stages of Vegetation

SPECIES COMMON NAME	HERBACEOUS	HARDWOOD						CONIFEROUS					
		Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth	Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth
<u>AMPHIBIANS</u>													
Tiger Salamander	X	X	X					X	X				
Northwestern Salamander	X	X	X		X	X	X	X	X		X	X	X
Long-toed Salamander	X	X	X	X	X	X	X	X	X	X	X	X	X
Pacific Giant Salamander	X				X	X	X				X	X	X
Olympic Salamander						X	X					X	X
Rough-skinned Newt	X	X	X	X	X	X	X	X	X	X	X	X	X
Dunn's Salamander						X	X					X	X
Western Red-backed Salamander			X	X	X	X	X		X	X	X	X	X
Van Dyke's Salamander						X	X					X	X
Ensatina	X				X	X	X				X	X	X
Tailed Frog	X	X	X	X	X	X	X	X	X	X	X	X	X
Great Basin Spadefoot	X	X	X	X	X	X	X	X	X	X	X	X	X
Western Toad	X	X	X	X				X	X	X			
Woodhouse's Toad	X												
Pacific Treefrog	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-legged Frog	X	X			X	X	X	X			X	X	X
Western Spotted Frog	X	X	X	X	X			X	X	X	X		
Cascade's Frog	X	X	X	X	X	X	X	X	X	X	X	X	X
Leopard Frog	X												
Bullfrog	X	X	X	X	X	X	X	X	X	X	X	X	X
Green Frog	X												
<u>REPTILES</u>													
Western Pond Turtle	X												
Painted Turtle	X												
Northern Alligator Lizard	X				X	X	X				X	X	X
Southern Alligator Lizard	X	X	X	X	X	X	X	X	X	X	X	X	X
Sagebrush Lizard		X	X	X	X	X	X	X	X	X	X	X	X
Western Skink	X	X	X	X	X	X	X	X	X	X	X	X	X
Common Gartersnake	X	X	X	X	X	X	X	X	X	X	X	X	X
Northwestern Gartersnake	X							X	X	X			
Western Gartersnake	X	X	X	X	X	X	X	X	X	X	X	X	X
Ringneck Snake	X	X	X	X	X	X	X	X	X	X	X	X	X
Racer	X	X	X					X	X				
Pine (gopher) Snake	X	X	X	X	X	X	X	X	X	X	X	X	X
Sharp-tailed Snake	X	X	X	X	X	X	X	X	X	X	X	X	X
Western Rattlesnake	X	X	X	X	X	X	X	X	X	X	X	X	X
Striped Whipsnake								X	X	X	X	X	X
Rubber Boa	X			X	X	X	X			X	X	X	X

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FOREST RIPARIAN HABITAT STUDY (Continued)

Presence of Wildlife in Riparian Ecosystems - By Successional Stages of Vegetation

SPECIES COMMON NAME	HERBACEOUS	HARDWOOD						CONIFEROUS					
		Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth	Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth
BIRDS													
Common Loon	X												
Western Grebe	X												
Pied-billed Grebe	X												
Great Blue Heron	X	X	X	X	X	X	X	X	X	X	X	X	X
Green Heron						X	X						
Snowy Egret	X												
Great Egret	X							X					
Black-crowned Night Heron	X					X	X						
American Bittern	X												
Whistling Swan	X												
Trumpeter Swan	X												
Canada Goose	X	X						X					
White-fronted Goose	X	X						X					
Snow Goose	X												
Ross Goose	X												
Mallard	X	X	X		X	X	X	X	X		X	X	X
Gadwall	X	X	X					X	X				
Pintail	X							X	X				
Green-winged Teal	X							X	X				
Blue-winged Teal	X							X	X				
Cinnamon Teal	X							X	X				
American Wigeon	X							X	X				
Shoveler	X							X	X				
Wood Duck					X	X	X				X	X	X
Redhead	X												
Ring-necked Duck	X							X					
Canvasback	X							X					
Greater Scaup	X												
Lesser Scaup	X												
Common Goldeneye	X												
Bufflehead	X				X	X					X	X	
Ruddy Duck	X												
Hooded Merganser						X	X					X	X
Common Merganser			X		X	X			X		X	X	
Turkey Vulture	X	X	X	X	X	X	X	X	X	X	X	X	X
Goshawk					X	X	X				X	X	X
Sharp-shinned Hawk	X		X	X	X	X	X		X	X	X	X	X
Cooper's Hawk	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-tailed Hawk	X	X	X		X	X	X	X	X		X	X	X
Swainson's Hawk	X	X	X			X	X	X	X			X	X
Rough-legged Hawk	X	X	X					X	X				
Golden Eagle	X	X	X			X	X	X	X			X	X
Bald Eagle	X	X	X			X	X	X	X			X	X

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FOREST RIPARIAN HABITAT STUDY (Continued)

Presence of Wildlife in Riparian Ecosystems - By Successional Stages of Vegetation

SPECIES COMMON NAME	HERBACEOUS	HARDWOOD Grass-Forb	HARDWOOD Shrub Dominated	HARDWOOD Pole-Sapling Dominated	HARDWOOD Young Forest	HARDWOOD Mature Forest	HARDWOOD Old Growth	CONIFEROUS Grass-Forb	CONIFEROUS Shrub Dominated	CONIFEROUS Pole-Sapling Dominated	CONIFEROUS Young Forest	CONIFEROUS Mature Forest	CONIFEROUS Old Growth
Marsh Hawk	X							X	X				
Osprey	X					X	X					X	X
Gyrfalcon	X							X	X				
Peregrine Falcon	X							X	X			X	X
Merlin		X	X	X	X	X	X	X	X	X	X	X	X
American Kestrel	X	X	X	X	X	X	X	X	X	X	X	X	X
Blue Grouse	X	X	X	X	X	X	X	X	X	X	X	X	X
Spruce Grouse	X							X	X	X	X	X	X
Ruffed Grouse			X	X	X	X			X	X	X	X	
California Quail	X	X	X	X				X	X	X			
Mountain Quail	X	X	X	X				X	X	X			
Turkey	X	X	X	X	X	X	X	X	X	X	X	X	X
Sandhill Crane	X	X						X					
Virginia Rail	X												
Sora	X												
American Coot	X	X	X					X	X				
Semipalmated Plover	X							X					
Killdeer	X	X						X					
Common Snipe	X	X	X					X	X				
Spotted Sandpiper	X	X						X					
Solitary Sandpiper	X	X						X					
Willet	X							X					
Greater Yellowlegs	X							X					
Lesser Yellowlegs	X							X					
Long-billed Dowitcher	X												
Western Sandpiper	X	X						X					
American Avocet	X							X					
Wilson's Phalarope	X							X	X				
California Gull	X	X						X					
Ring-billed Gull	X	X						X					
Franklin's Gull	X												
Black Tern	X							X					
Band-tailed Pigeon		X	X	X	X	X	X	X	X	X	X	X	X
Mourning Dove	X	X	X	X	X	X	X	X	X	X	X	X	X
Barn Owl	X	X	X	X	X	X	X	X	X	X	X	X	X
Screech Owl	X	X	X	X	X	X	X	X	X	X	X	X	X
Great Horned Owl	X	X	X	X	X	X	X	X	X	X	X	X	X
Pygmy Owl	X	X	X	X	X	X	X	X	X	X	X	X	X
Great Gray Owl	X	X	X	X	X	X	X	X	X	X	X	X	X
Long-eared Owl	X	X	X	X	X	X	X	X	X	X	X	X	X
Saw-whet Owl			X	X	X	X	X		X	X	X	X	X
Barred Owl												X	X

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FOREST RIPARIAN HABITAT STUDY (Continued)

Presence of Wildlife in Riparian Ecosystems - By Successional Stages of Vegetation

SPECIES COMMON NAME	HERBACEOUS	HARDWOOD						CONIFEROUS					
		Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth	Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth
Northern Spotted Owl					X	X	X				X	X	X
Vaux's Swift						X	X					X	X
White-throated Swift								X	X				
Common Nighthawk	X	X	X					X	X				
Black-chinned Hummingbird	X	X	X					X	X				
Rufous Hummingbird	X	X	X	X	X	X	X	X	X	X	X	X	X
Calliope Hummingbird	X	X	X					X	X				
Belted Kingfisher	X	X	X	X	X	X	X	X	X	X	X	X	X
Common Flicker	X	X	X	X	X	X	X	X	X	X	X	X	X
Eastern Kingbird	X	X	X	X	X	X		X	X	X	X	X	
Western Kingbird	X	X	X			X		X	X			X	
Say's Phoebe	X	X	X					X	X				
Hammond's Flycatcher											X	X	X
Dusky Flycatcher			X	X	X				X	X	X		
Western Flycatcher					X	X	X				X	X	X
Western Wood Pewee			X	X	X	X	X		X	X	X	X	X
Olive-sided Flycatcher		X	X	X	X	X	X	X	X	X	X	X	X
Willow Flycatcher			X	X	X	X			X	X	X	X	
Violet-green Swallow	X	X	X	X	X	X	X	X	X	X	X	X	X
Tree Swallow	X	X	X			X	X	X	X			X	X
Bank Swallow	X							X	X				
Rough-winged Swallow	X	X						X					
Barn Swallow	X	X						X					
Cliff Swallow	X	X						X					
Purple Martin	X	X	X					X	X				
Steller's Jay			X	X	X	X	X		X	X	X	X	X
Common Raven	X	X	X			X	X	X	X			X	X
Common Crow	X	X	X	X	X	X	X	X	X	X	X	X	X
Black-capped Chickadee			X	X	X	X	X		X	X	X	X	X
Boreal Chickadee										X	X	X	X
Chestnut-backed Chickadee				X	X	X	X			X	X	X	X
Bushtit			X	X	X				X	X	X		
White-breasted Nuthatch			X	X	X	X	X		X	X	X	X	X
Red-breasted Nuthatch				X	X	X	X			X	X	X	X
Pygmy Nuthatch										X	X	X	X
Brown Creeper						X	X					X	X
Dipper	X	X	X	X	X	X	X	X	X	X	X	X	X
House Wren			X	X	X				X	X	X		
Winter Wren						X	X					X	X
Bewick's Wren			X	X	X	X			X	X	X	X	
Long-billed Marsh Wren	X												
Catbird			X	X					X	X			
American Robin	X	X	X	X	X	X	X	X	X	X	X	X	X
Varied Thrush				X	X	X	X			X	X	X	X

AV/W36(A3,14-15)

FOREST RIPARIAN HABITAT STUDY (Continued)

Presence of Wildlife in Riparian Ecosystems - By Successional Stages of Vegetation

SPECIES COMMON NAME	HERBACEOUS	HARDWOOD						CONIFEROUS					
		Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth	Grass-Forb	Shrub Dominated	Pole-Sapling Dominated	Young Forest	Mature Forest	Old Growth
Hermit Thrush	X			X	X	X	X			X	X	X	X
Swainson's Thrush			X	X	X	X	X		X	X	X	X	X
Veery			X	X	X								
Bohemian Waxwing	X		X	X	X	X			X	X	X	X	
Cedar Waxwing			X	X	X	X			X	X	X	X	
Hutton's Vireo			X	X	X	X			X	X	X	X	
Red-eyed Vireo				X	X	X				X	X	X	
Warbling Vireo				X	X	X	X			X	X	X	X
Yellow Warbler			X	X	X	X	X		X	X	X	X	X
Northern Waterthrush			X	X	X	X			X	X	X	X	
MacGillivray's Warbler			X	X	X	X			X	X	X	X	
Yellowthroat	X	X	X										
Yellow-breasted Chat	X		X	X	X				X	X	X		
Wilson's Warbler			X	X					X	X			
American Redstart			X	X	X				X	X	X		
Yellow-rumped Warbler	X		X	X	X	X	X		X	X	X	X	X
Yellow-headed Blackbird	X												
Red-winged Blackbird	X	X	X					X	X				
Brewer's Blackbird	X	X	X	X				X	X	X			
Northern Oriole		X	X			X	X	X	X			X	X
Brown-headed Cowbird	X	X	X	X	X	X	X	X	X	X	X	X	X
Western Tanager				X	X	X	X			X	X	X	X
Black-headed Grosbeak					X	X	X				X	X	X
Evening Grosbeak			X	X	X	X	X		X	X	X	X	X
Lazuli Bunting			X	X					X	X			
Purple Finch				X	X	X	X			X	X	X	X
Cassin's Finch	X							X	X	X	X	X	X
House Finch			X	X	X				X	X	X		
American Goldfinch		X	X	X	X			X	X	X	X		
Rufous-sided Towhee			X	X	X				X	X	X		
Dark-eyed Junco	X	X	X	X	X	X	X	X	X	X	X	X	X
Tree Sparrow	X	X	X										
Chipping Sparrow	X	X	X	X	X			X	X	X	X		
White-crowned Sparrow	X	X	X	X				X	X	X			
Golden-crowned Sparrow		X	X					X	X				
Fox Sparrow			X	X	X				X	X	X		
Lincoln's Sparrow									X	X			
Song Sparrow	X	X	X	X				X	X	X			

AV/W36(A3,16-17)

APPENDIX B

LIST OF FISH SPECIES FOUND IN FRESH AND INTERTIDAL WATERS OF WASHINGTON

LIFE HISTORY DESCRIPTIONS FOR SALMONID FISHES FOUND IN WASHINGTON

MATRICES 1, 2, AND 4 THROUGH 7

MATRICES 8, 9, AND 11 THROUGH 15

CHECKLIST OF THE INLAND FISHES OF WASHINGTON

Common Name	Scientific Name	Location	Occurrence
Family PETROMYZONTIDAE, lampreys			
Pacific lamprey	*Entosphenus tridentatus* (Gairdner)	Anadromous	Widespread in coastal and Columbia R. drainages; occurs in ID, OR
River lamprey	*Lampetra ayresi* (Günther)	Anadromous	Widespread in coastal and Columbia R. drainages, occurs in ID, OR
Western brook lamprey	*Lampetra richardsoni* Vladykov and Follett	Fresh-water	Widespread, common in Puget Sound; abundant in coastal drainage; occurs in OR
Family ACIPENSERIDAE, sturgeons			
Green sturgeon	*Acipenser medirostris* Ayres	Marine and occasionally fresh-water	Common in coastal drainage; occurs in OR
White sturgeon	*Acipenser transmontanus* Richardson	Anadromous	Common in coastal and Columbia R. drainages; occurs in ID, OR
Family CLUPEIDAE, herrings			
American shad*	*Alosa sapidissima* (Wilson)	Anadromous	Abundant in Columbia R. drainage; occurs in ID, OR
Family SALMONIDAE, trouts			
Lake whitefish*	*Coregonus clupeaformis* (Mitchill)	Fresh-water	Restricted distribution; abundant in Banks Lake; occurs in ID
Pink salmon	*Oncorhynchus gorbuscha* (Walbaum)	Anadromous	Widespread, abundant in Puget Sound drainage; locally abundant in coastal drainage; occurs in OR
Chum salmon	*Oncorhynchus keta* (Walbaum)	Anadromous	Widespread; abundant in Puget Sound drainage, locally abundant in coastal and (formerly) Columbia R. drainages; occurs in OR
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	Anadromous	Widespread; abundant in Puget Sound, coastal, and Columbia R. drainages; occurs in ID, OR
Sockeye salmon (kokanee)	*Oncorhynchus nerka* (Walbaum)	Anadromous and landlocked	Locally abundant in Puget Sound, coastal (Quinault), and (formerly) Columbia R. drainages; occurs in ID, OR
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	Anadromous and landlocked	Widespread, abundant in Puget Sound, coastal, and Columbia R. drainages; occurs in ID, OR

From: Wydoski, R.S. and Whitney, R.W. (33).

Pygmy whitefish	*Prosopium coulteri* (Eigenmann & Eigenmann)	Fresh-water	Restricted distribution; abundant in Lake Chester Morse; occurs in ID
Mountain whitefish	*Prosopium williamsoni* (Girard)	Fresh-water	Widespread and abundant; occurs in ID, OR
Golden trout*	*Salmo aguabonita* Jordan	Fresh-water	Restricted distribution; common in certain mountain lakes; occurs in ID, OR
Cutthroat trout	*Salmo clarki* Richardson	Anadromous and fresh-water	Widespread; abundant in numerous lakes and streams; occurs in ID, OR
Rainbow trout (steelhead)	*Salmo gairdneri* Richardson	Anadromous and fresh-water	Widespread; abundant in numerous lakes and streams; occurs in ID, OR
Atlantic salmon†	*Salmo salar* Linnaeus	Fresh-water	Restricted distribution; abundant in Chopaca Lake; occurs in ID, OR
Brown trout*	*Salmo trutta* Linnaeus	Fresh-water	Locally abundant in Columbia Basin and Blue Mtns; occurs in ID, OR
Brook trout*	*Salvelinus fontinalis* (Mitchill)	Fresh-water	Abundant in scattered streams and lakes; occurs in ID, OR
Dolly Varden	*Salvelinus malma* (Walbaum)	Fresh-water	Widespread and locally abundant in scattered streams and lakes; occurs in ID, OR
Lake trout*	*Salvelinus namaycush* (Walbaum)	Fresh-water	Restricted distribution; abundant in scattered lakes; occurs in ID, OR
Arctic grayling*	*Thymallus arcticus* (Pallas)	Fresh-water	Rare; abundant in one mountain lake; occurs in ID
Family OSMERIDAE, smelts			
Longfin smelt	*Spirinchus thaleichthys* (Ayres)	Anadromous and landlocked	Widespread; abundant in Puget Sound drainage and L. Washington; occurs in OR
Eulachon	*Thaleichthys pacificus* (Richardson)	Anadromous	Abundant in Columbia R. drainage; occurs in OR
Family UMBRIDAE, mudminnows			
Olympic mudminnow	*Novumbra hubbsi* Schultz	Fresh-water	Found only in western Washington; locally abundant on Olympic Peninsula and in southern end of Puget Sound drainage
Family ESOCIDAE, pikes			
Grass pickerel*	*Esox americanus vermiculatus* Lesueur	Fresh-water	Restricted to two lakes in eastern Columbia Basin, where it is abumdant
Family CYPRINIDAE, minnows and carps			
Chiselmouth	*Acrocheilus alutaceus* Agassiz and Pickering	Fresh-water	Widespread and abundant east of the Cascade Mtns.; occurs in ID, OR
Goldfish*	*Carassius auratus* (Linnaeus)	Fresh-water	Abundant in scattered lakes; occurs in ID, OR

Common Name	Scientific Name	Location	Occurrence
Lake chub	*Couesius plumbeus* (Agassiz)	Fresh-water	Restricted distribution; locally abundant in upper Columbia R. drainage; occurs in ID
Carp*	*Cyprinus carpio* Linnaeus	Fresh-water	Widespread and abundant; occurs in ID, OR
Tui chub	*Gila bicolor* (Girard)	Fresh-water	Abundant in Columbia Basin; occurs in ID, OR
Peamouth	*Mylocheilus caurinus* (Richardson)	Fresh-water	Widespread; abundant in coastal, Puget Sound, and Columbia R. drainages; occurs in ID, OR
Northern squawfish	*Ptychocheilus oregonensis* (Richardson)	Fresh-water	Widespread and abundant, occurs in ID, OR
Longnose dace	*Rhinichthys cataractae* (Valenciennes)	Fresh-water	Widespread and abundant; occurs in ID, OR
Leopard dace	*Rhinichthys falcatus* (Eigenmann and Eigenmann)	Fresh-water	Common in Upper Columbia R. drainage; occurs in ID, OR
Speckled dace	*Rhinichthys osculus* (Girard)	Fresh-water	Widespread and abundant; occurs in ID, OR
Redside shiner	*Richardsonius balteatus* (Richardson)	Fresh-water	Widespread and abundant, occurs in ID, OR
Tench*	*Tinca tinca* (Linnaeus)	Fresh-water	Rare; occurs in Lake Washington, Columbia R., and Spokane R.; occurs in ID, OR
Family CATOSTOMIDAE, suckers			
Longnose sucker	*Catostomus catostomus* (Forster)	Fresh-water	Widespread and abundant in Columbia Basin east of the Cascade Mtns.; occurs in ID
Bridgelip sucker	*Catostomus columbianus* (Eigenmann and Eigenmann)	Fresh-water	Locally abundant in Upper Columbia R. drainage; occurs in ID, OR
Largescale sucker	*Catostomus macrocheilus* (Girard)	Fresh-water	Widespread and abundant; occurs in ID, OR
Mountain sucker	*Catostomus platyrhynchus* (Cope)	Fresh-water	Restricted distribution; common in Upper Columbia R. drainage; occurs in ID, OR
Family ICTALURIDAE, freshwater catfishes			
Black bullhead*	*Ictalurus melas* (Rafinesque)	Fresh-water	Rare; in Columbia R. drainage; occurs in ID, OR
Yellow bullhead*	*Ictalurus natalis* (Lesueur)	Fresh-water	Rare; unknown; occurs in OR
Brown bullhead*	*Ictalurus nebulosus* (Lesueur)	Fresh-water	Widespread and abundant; occurs in ID, OR
Channel catfish*	*Ictalurus punctatus* (Rafinesque)	Fresh-water	Abundant in Columbia R. drainage; occurs in ID, OR
Tadpole madtom*	*Noturus gyrinus* (Mitchill)	Fresh-water	Rare; in Columbia R. drainage; occurs in ID, OR
Family PERCOPSIDAE, trout perches			
Sand roller	*Percopsis transmontanus* (Eigenmann and Eigenmann)	Fresh-water	Common in Columbia R. drainage; occurs in ID, OR

4

Family GADIDAE, codfishes			
Burbot	*Lota lota* (Linnaeus)	Fresh-water	Common in scattered lakes; occurs in ID, OR
Family POECILLIDAE, livebearers			
Mosquitofish*	*Gambusia affinis* (Baird and Girard)	Fresh-water	Abundant in isolated ponds; occurs in ID, OR
Family GASTEROSTEIDAE, sticklebacks			
Three-spine stickleback	*Gasterosteus aculeatus* (Linnaeus)	Marine and occasionally fresh-water	Widespread; abundant in western Washington; occurs in OR
Family PERCICHTHYIDAE, temperate basses			
Striped bass*	*Morone saxatilis* (Walbaum)	Anadromous	Rare; in Columbia R. drainage and Grays Harbor; occurs in OR
Family CENTRARCHIDAE, sunfishes			
Rock bass*	*Ambloplites rupestris* (Rafinesque)	Fresh-water	Locally abundant in scattered lakes and streams
Green sunfish*	*Lepomis cyanellus* (Rafinesque)	Fresh-water	Locally abundant in isolated lakes near Spokane; occurs in ID, OR
Pumpkinseed*	*Lepomis gibbosus* (Linnaeus)	Fresh-water	Widespread and abundant; occurs in ID, OR
Warmouth*	*Lepomis gulosus* (Cuvier)	Fresh-water	Locally abundant in scattered lakes; occurs in ID, OR
Bluegill*	*Lepomis macrochirus* (Rafinesque)	Fresh-water	Widespread and abundant in eastern Washington; occurs in ID, OR
Smallmouth bass*	*Micropterus dolomieui* (Lacépède)	Fresh-water	Common in L. Washington and L. Sammamish, Columbia R. and Snake R.; occurs in ID, OR
Largemouth bass*	*Micropterus salmoides* (Lacépède)	Fresh-water	Widespread and abundant; occurs in ID, OR
White crappie*	*Pomoxis annularis* (Rafinesque)	Fresh-water	Abundant in McNary Pool and Columbia R.; occurs in ID, OR
Black crappie*	*Pomoxis nigromaculatus* (Lesueur)	Fresh-water	Widespread and locally abundant; occurs in ID, OR
Family PERCIDAE, perches			
Yellow perch*	*Perca flavescens* (Mitchill)	Fresh-water	Widespread and abundant; occurs in ID, OR
Walleye*	*Stizostedion vitreum vitreum* (Mitchill)	Fresh-water	Common in Columbia R. and Banks Lake; occurs in ID, OR
Family EMBIOTOCIDAE, surfperches			
Shiner perch	*Cymatogaster aggregata* (Gibbons)	Marine and occasionally fresh water	Widespread and abundant in coastal and Puget Sound drainages; occurs in OR
Family PLEURONECTIDAE, righteye flounders			
Starry flounder	*Platichthys stellatus* (Pallas)	Marine, occasionally occurs in fresh water	Widespread and abundant in Columbia R., coastal, and Puget Sound drainages; occurs in OR

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Common Name	Scientific Name	Location	Occurrence
Family COTTIDAE, sculpins			
Coastrange sculpin	*Cottus aleuticus* (Gilbert)	Fresh-water	Widespread; abundant in coastal and Puget Sound drainages; occurs in OR
Prickly sculpin	*Cottus asper* (Richardson)	Fresh-water	Widespread; abundant in coastal and Puget Sound drainages; occurs in OR
Mottled sculpin	*Cottus bairdi* (Girard)	Fresh-water	Common in Upper Columbia R. drainage; occurs in ID, OR
Piute sculpin	*Cottus beldingi* (Eigenmann and Eigenmann)	Fresh-water	Common in Columbia R. drainages; occurs in ID, OR
Slimy sculpin	*Cottus cognatus* (Richardson)	Fresh-water	Rare; common in tributaries to L. Chelan; occurs in OR
Shorthead sculpin	*Cottus confusus* (Bailey and Bond)	Fresh-water	Widespread; abundant in scattered streams; occurs in OR
Riffle sculpin	*Cottus gulosus* (Girard)	Fresh-water	Widespread; abundant in coastal and Puget Sound drainages; occurs in OR
Margined sculpin	*Cottus marginatus* (Bean)	Fresh-water	Rare; locally abundant in streams in Blue Mtns.; occurs in OR
Reticulate sculpin	*Cottus perplexus* (Gilbert and Evermann)	Fresh-water	Widespread; abundant in coastal drainage; occurs in OR
Torrent sculpin	*Cottus rhotheus* (Smith)	Fresh-water	Widespread; abundant; occurs in ID, OR
Pacific staghorn sculpin	*Leptocottus armatus* (Girard)	Marine and occasionally fresh-water	Widespread; abundant in coastal and Puget Sound drainages; occurs in OR

NOTE: Species arranged in phylogenetic order.
* Species not native to Washington, but was introduced.
† Continued presence dependent on stocking.

LIST OF FRESHWATER FISH SPECIES

Wydoski and Whitney (1979) list 77 species of fish which inhabit freshwater in Washington for all or a potion of their life. They include members of 19 different taxonomic families; notably salmonidae (salmon, trout and charr), cyprinidae (minnows and carps), catostomidae (suckers), centrarchidae (sunfish and bass), acipenseridae (sturgeons), and cottidae (sculpins). The salmonids will be featured in the following discussion generally because they are the fish most likely to occur in forested watersheds. The other species while important in their own right are ususally not affected by forest practices. For those that are, it is assumed if habitat requirements for salmonids are met their needs will also be met.

Salmonids are further divided into two major life history groups, anadromous (sea-run) and resident. Several species have both life histories. Salmonids are found from the tiniest mountain stream to the largest river, from alpine lakes to beaver ponds, sloughs and lowland lakes. Depending upon life history and stream location, adult or juvenile salmonids can be found in freshwater environments year-round. The generalize timing of the anadromous species is shown in Table -1.

The following is a brief discussion of the major anadromous and resident salmonid species.

Chinook Salmon

Also known as the king salmon, the chinook salmon is found generally in larger rivers such as the Stilliguamish, Hoh, Satsop, Lewis, Cowlitz, Yakima, and Wenatchee. There are three races within the species; their names derived from the timing of adults into freshwater. These arethe spring, summer and fall chinook. Spring chinook are generally associated with glaciated rivers and have the longest upstream migration of the three. Summers are found in only a few rivers, most notably the Skagit system. Fall chinook are most common. The three races are further distinguished by spawning timing with spring spawning from mid-August to mid-September, the summers a bit later and the falls from late September to early November. After the fry emerge from the spawning nest within the streambed, springs spend up to two years in freshwater, summers up to one year and falls usually 90 days before seaward migration. Adults mature at age 3-5 at an average weight of 20-25 lbs. In addition, a portion of each run is composed of precocious males or "jacks" which return as two-year olds.

Sockeye Salmon

This species, also known as red salmon, is not widespread in Washington. The largest run returns to Lake Washington (average return is 300,000-400,000). The other runs occur in Okanogan River (Lake Osoyoos) in the Baker River near Concrete, in Lake Ozette, and Lake Quinault. The Wenatchee River sockeye spawn in a lake inlet or outlet, or along pebbly lake beaches where spring flows up well through the gravel. Immediately following emergence these fish reside in the lake for 2 years prior to sea-ward migration. They return to freshwater at age 4-5 as 4-6 lb. fish. Spawning occurs mid-August to mid-September. A land locked variety, the kokanie, is found in several areas most notably Lake Sammamish and Swift Reservoir. Life history is similar except for much smaller size.

Pink Salmon

These fish, also called humpies, are most common in streams in Puget sound and Hood Canal. They occur most notably in the Snohomish, Skagit, and Stilliguamish rivers in Puget Sound and the Dosewallips in Hood Canal. Pinks return on a strict two year cycle on the odd year (i.e. 1983, 1985, etc.). They spawn from the main streams of large rivers, in sloughs, and side channels down to tiny creeks 6-10 feet wide. The fry migrate immediately to sea following emergence. Adults weigh 3-5 lbs. Spawning occurs from mid-July to mid-October depending upon the stream.

Chum Salmon

Commonly called dog salmon because of the large canine teeth in the spawning male, these fish are found in heaviest abundance in Puget Sound, in moderate abundance on the coast and to much lessr extent in the Columbia drainage. Like pinks, the fry emerge and immediately migrate seaward. Adults return as 3-5 year olds, weighing 9-10 lbs.. Spawning occurs from early September (Dawatto, Tahuya, Quilcene rivers) to early March (Nisqually River) depending upon the stream. Spawning habitat is similar to that described for pink salmon.

Coho Salmon

Also called silvers, these fish are most widespread of the salmon species. Abundance varies but run streangths are roughly equal on the west side but minimal on the east side of the Cascade Mountains. These fish typically spend 1 year in freshwater and two years at sea, returning as 3 year olds. As with chinook, a portion return as 2 year old jacks. Coho spawn in a variety of stream habitats but are best known for their ability to penetrate into the tiniest streams often moving on flood flows into streams which are dry during summer but the only source of spawning gravel during winter. Coho salmon weigh 5-8 pounds at maturity and spawn from late October to early February again depending upon the stream. All species of salmon die after spawning.

Steelhead and Rainbow Trout

Steelhead occur as two distinct races; summer and winter. Winter steelhead are present in most larger rivers and streams and predominate over summers which are ususlly only found in larger rivers. Some juveniles migrate after 1 year in freshwater, however, most are 2 year residents. Adults weigh 5-10 lbs.. Spawning occurs from early spring to early summer.

The resident rainbow trout ingabits larger rivers to small streams and lakes of various sizes throughout Washington attaining size of 6-10 inches at age 2. Spawning occurs from February to June depending upon water temperature and location. Although these fish ar not anadromous various migrations occur such as from lake to spawning stream or from a spawning area to a rearing area and back. Death does not always occur after spawning; some individuals spawning 2 or 3 times.

Cutthroat Trout

The cutthroat trout is the most common resident trout species occurring in western Washington streams and the sea-run form is common in most lowland coastal, Puget Sound and Columbia River streams. The introduced intermountain form is present in the Cascade Mountains and in may lakes and streams of Eastern Washington. Coastal cutthroat spawn in the smallest headwater streams generally upstream of the salmon and steelhead. Spawning occurs from December to February. Resident stocks generally spawn in April and early May. The sea-run form spends from 2-9 years (average 3) in freshwater before migrating. These fish usually remain close to their natal stream making occasional forays back to freshwater for feeding. Spawning fish generally return as 4-5 year olds weighing 1-2 lbs.. Resident forms are generally smaller in streams, however, lake forms may attain weights of 20 or more pounds.

Dolly Varden Charr

"Dollies" are often confused with trout because of their similar anatomy. There are two forms; anadromous and resident. The Dolly Varden is distributed widely throughout Washington with notable anadromous runs in the Skagit, Samish, Elwha and Quinault rivers. Generally, however the populations while widely distributed are not large. Sea-run varieties attain sexual maturity at age 3-6 with weights averaging 5 lbs., but weights of greater than 30 lbs. have been reported. Dollies are fall spawners.

Brook Trout

Another charr, "brookies" are most common in mountain lakes and in northeastern streams and lakes. There are no anadromous forms. Brook trout prefer cool clear headwater ponds and spring fed streams. Average life span is 4 years. Spawning occurs during late September.

Whitefish

Three species are known to inhabit Washington waters; the lake whitefish, the pygmy whitefish, and the mountain whitefish. The mountain whitefish is the most common occurring throughout Washington. Generally they inhabit larger streams. They reach sexual maturity at age 3-4, and have been recorded up to 11 years old. Spawning occurs in the fall.

Atlantic salmon, lake trout, golden trout, and arctic grayling also inhabit waters but their numbers and distribution is limited to a few lakes and therefore, do not require discussion.

Table --Seasonal occurrence of adult and juvenile (eggs and young) andromous salmonids in freshwaters of Washington

```
                     Jan.  Feb.  Mar.  Apr.  May   June  July  Aug.  Sept.  Oct.  Nov.  Dec.

                     -------                                                -----------------
Coho          Adult  xxxxxxx                                                xxxxxxxxxxxxxxxxx
              Young  oooooooooooooooooooooo                                 ooooooooooooooooo
                     ________________________________________________________________________
                                  ++++++++++++++++++++++++

Fall          Adult                                                 ---------------------
                                                                              xxxxxxxxxxxx
Chinook       Young  ooooooooooo                                              ooooooooooooooooooooo
                          _________________________________________________
                                 +++++++++++++++++++++++++++++

Spring        Adult        ---------------------------------

                                                                    xxxxxxxxxxxxx
Chinook       Young  ooooooo                                        ooooooooooooooooooooooooooooooo
                     __________________________________________________________________________
                                 +++++++++++++++++++++++++

Sockeye       Adult    --                           ------------------

                                                                    xxxxxxxxxxxxxxxxx
              Young  ooooo                                          ooooooooooooooooooooooooooooooo
                     __________________________________________________________________________
                                 ++++++++++++++++++++

                     ---------
Chum          Adult  xxxxxxxxx..
                                                                   --------------------------------
                                                                   xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
              Young  oooooooooooooooooooooooooo                    oooooooooooooooooooooooooooooooo
                       ++++++++++++++++++++++++++

Pink          Adult
                                                  --------------------------
                                                  xxxxxxxxxxxxxxxxxxxxxxxxxx
              Young  oooooooo                     ooooooooooooooooooooooooooooooooooooooooooo
                         ++++++++++++++++                                                ______

                     ----------------------
Winter        Adult     xxxxxxxxxxxxxxxxxxxxxxxxxxxxx                             -----------
                        ooooooooooooooooooooooooooooooooooooo
Steelhead     Young  __________________________________________________________________________
                                  ++++++++++++++++++++++

Summer        Adult  ----------                 --------------------------------------------
                               xxxxxxxxxxxxxx
                               oooooooooooooooooooooooooooo
              Young  __________________________________________________________________________
                                      +++++++++++++++++++++

                     --------
Searun        Adult                                                 ------------------------------
                     xxxx                                                                    xxxxx
                     oooooooooooo                                                            ooooo
              Young  __________________________________________________________________________
                                +++++++++++++++++++++++++++

                                                                    ----------------
Dolly Varden  Adult                                                 xxxxxxxxxxxxxxxx
                                                                    oooooooooooooooooooooo
                     oooo
              Young  __________________________________________________________________________
                                 +++++++++++++++++++++++
```

--- Upstream migration (adults)
xxx Spawning
ooo Eggs
+++ Downstream migration

MATRIX 1. RELATIVE CONTRIBUTION OF FISH HABITAT COMPONENTS FROM SUCCESSIONAL STAGES OF RIPARIAN VEGETATION (TYPE 1 STREAM)

	SUCCESSIONAL STAGE						
HABITAT COMPONENT	deveg- etated	grass, forb-shrub	pole-sapling young/conif.	pole-sapling young/hrwd.	mature/ conifer	mature/ hrwd.	old growth
WOODY DEBRIS	0	0	0-2	0-2	2-3	2-3	3
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	1	2-3	1	1-2	2	2	3
BANK COVER	0	0	1-2	2-3	3	3	3
THERMAL CONTROL	0	0	1-2	1-2	2-3	2-3	2-3
BANK STABILITY	0	1-2	2-3	2-3	3	3	2-3
SEDIMENT TRAPPING	0	1-3	1-2	1-2	2-3	2-3	3
SOLAR INPUT	2-3	2-3	2-3	2-3	1-2	1-2	2
Total	3-4	6-12	9-17	11-18	17.5-21.5	18-22	20.5-23

CONTRIBUTION : 0 - none recognized; 1 - low; 2 - medium; 3 - high

MATRIX 2. RELATIVE CONTRIBUTION OF FISH HABITAT COMPONENTS FROM SUCCESSIONAL STAGES OF RIPARIAN VEGETATION (TYPE 2 STREAM)

HABITAT COMPONENT	SUCCESSIONAL STAGE						
	deveg-etated	grass, forb-shrub	pole-sapling young/conif.	pole-sapling young/hrwd.	mature/ conifer	mature/ hrwd.	old growth
WOODY DEBRIS	0	0	1-2	1-2	2-3	2-3	3
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	1	2-3	1	1-2	2	2	3
BANK COVER	0	1-2	1-2	2-3	3	3	3
THERMAL CONTROL	0	0-1	1-3	2-3	3	3	3
BANK STABILITY	0	1-2	2-3	2-3	3	3	2-3
SEDIMENT TRAPPING	0	1-3	1-2	1-2	2-3	2-3	3
SOLAR INPUT	3	2-3	0-2	0-1	0	0	0
Total	4	7-15	8-17	11-18	17.5-19.5	18-20	17.5-21

CONTRIBUTION : 0 - none recognized; 1 - low; 2 - medium; 3 - high

MATRIX 4. RELATIVE CONTRIBUTION OF FISH HABITAT COMPONENTS FROM SUCCESSIONAL STAGES OF RIPARIAN VEGETATION (TYPE 4-5 STREAM)

HABITAT COMPONENT	........................SUCCESSIONAL STAGE						
	deveg-etated	grass, forb-shrub	pole-sapling young/conif.	pole-sapling young/hrwd.	mature/conifer	mature/hrwd.	old growth
WOODY DEBRIS	0	0-1	1-3	1-3	3	3	3
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	1	2-3	1	1-2	2	2	3
BANK COVER	0	0	1-2	2-3	3	3	3
THERMAL CONTROL	0	0-3	3	3	3	3	3
BANK STABILITY	0	1-2	2-3	2-3	3	3	2-3
SEDIMENT TRAPPING	0	1-3	1-2	1-2	2-3	2-3	3
SOLAR INPUT	3	0-3	0	0	0	0	0
Total	4	6-16	10-16	12-18	18.5-19.5	19-20	19.5-21

CONTRIBUTION : 0 - none recognized; 1 - low; 2 - medium; 3 - high

MATRIX 5. RELATIVE CONTRIBUTION OF FISH HABITAT COMPONENTS FROM SUCCESSIONAL STAGES OF RIPARIAN VEGETATION (TYPE 1 LAKE POND RES.)

HABITAT COMPONENT	SUCCESSIONAL STAGE						
	deveg-etated	grass, forb-shrub	pole-sapling young/conif.	pole-sapling young/hrwd.	mature/ conifer	mature/ hrwd.	old growth
WOODY DEBRIS	0	0	0-1	0-1	2	2	3
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	1	2-3	1	1-2	2	2	3
BANK COVER	0	0	1-2	2-3	3	3	3
THERMAL CONTROL	0	0	0	0	0	0	0
BANK STABILITY	0	1-2	2-3	2-3	3	3	2-3
SEDIMENT TRAPPING	0	1-3	1-2	1-2	2-3	2-3	3
SOLAR INPUT	3	3	3	3	3	3	3
Total	4	7-12	9-14	11-16	17.5-18.5	18-19	19.5-21

CONTRIBUTION : 0 - none recognized; 1 - low; 2 - medium; 3 - high

MATRIX 6. RELATIVE CONTRIBUTION OF FISH HABITAT COMPONENTS FROM SUCCESSIONAL STAGES OF RIPARIAN VEGETATION (TYPE 2 LAKE POND RES.)

HABITAT COMPONENT	SUCCESSIONAL STAGE						
	deveg-etated	grass, forb-shrub	pole-sapling young/conif.	pole-sapling young/hrwd.	mature/ conifer	mature/ hrwd.	old growth
WOODY DEBRIS	0	0	0-2	0-2	2-3	2-3	3
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	1	2-3	1	1-2	2	2	3
BANK COVER	0	0	1-2	2-3	3	3	3
THERMAL CONTROL	0	0	0-1	0-1	0-1	0-1	0-2
BANK STABILITY	0	1-2	2-3	2-3	3	3	2-3
SEDIMENT TRAPPING	0	1-3	1-2	1-2	2-3	2-3	3
SOLAR INPUT	3	3	2-3	2-3	2-3	2-3	1-2
Total	4	7-12	8-16	10-18	16.5-20.5	17-21	17.5-22

CONTRIBUTION : 0 - none recognized; 1 - low; 2 - medium; 3 - high

MATRIX 7. RELATIVE CONTRIBUTION OF FISH HABITAT COMPONENTS FROM SUCCESSIONAL STAGES OF RIPARIAN VEGETATION (TYPE 3 LAKE POND RES.)

	..........SUCCESSIONAL STAGE..........						
HABITAT COMPONENT	deveg-etated	grass, forb-shrub	pole-sapling young/conif.	pole-sapling young/hrwd.	mature/ conifer	mature/ hrwd.	old growth
WOODY DEBRIS	0	0	0-2	0-2	2-3	2-3	3
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	1	2-3	1	1-2	2	2	3
BANK COVER	0	0	1-2	2-3	3	3	3
THERMAL CONTROL	0	0-3	0-3	0-3	1-3	1-3	1-3
BANK STABILITY	0	1-2	2-3	2-3	3	3	2-3
SEDIMENT TRAPPING	0	1-2	1-2	1-2	2-3	2-3	3
SOLAR INPUT	3	2-3	0-3	0-3	0-2	0-2	0-2
Total	4	6-15	6-18	8-20	15.5-21.5	16-22	17.5-23

CONTRIBUTION : 0 -none recognized; 1 - low; 2 - medium; 3 - high

MATRIX 8. FISH HABITAT QUALITY RELATIVE TO SUCCESSIONAL STAGES OF RIPARIAN HABITAT 1/

(TYPE 1 STREAM)

HABITAT COMPONENT	devegetated	grass-forb-shrub	pole-sapling-young/conif.	pole-sapling-young/hdwd	mature/conif	mature/hdwd	old growth
WOODY DEBRIS	0	0	0-6	0-6	6-9	6-9	9
ORGANIC LITTER	0	0-2	1-4	2-4	2.5-5	3-6	2.5-6
TERRESTRIAL INVERTEBRATES	1-2	2-6	1-2	1-4	2-4	2-4	3-6
BANK COVER	0	0	2-4	4-6	6	6	6
THERMAL CONTROL	0	0	1-4	1-4	2-6	2-6	2-6
BANK STABILITY	0	3-9	6-9	6-9	9	9	6-9
SEDIMENT TRAPPING	0	3-9	3-6	3-6	6-9	6-9	9
SOLAR INPUT	6-9	6-9	6-9	6-9	3-6	3-6	6
TOTAL	7-11	14-32	20-44	23-48	36.5-54	37-55	43.5-57

CONTRIBUTION X IMPORTANCE = RELATIVE HABITAT QUALITY

CONTRIBUTION	IMPORTANCE
0 - none	0 - none recognized
1 - low	1 - low
2 - medium	2 - medium
3 - high	3 - high

1/ See text for explanation of matrix.

jsrfwls

MATRIX 9. FISH HABITAT QUALITY RELATIVE TO SUCCESSIONAL STAGES OF RIPARIAN VEGETATION 1/

(TYPE 2 STREAM)

HABITAT COMPONENT	devegetated	grass-forb-shrub	pole-sapling-young/conif.	pole-sapling-young/hdwd	mature/conif	mature/hdwd	old growth
WOODY DEBRIS	0	0	3-6	3-6	6-9	6-9	9
ORGANIC LITTER	0	0-2	2-4	4	5	6	5-6
TERRESTRIAL INVERTEBRATES	2-3	4-9	2-3	2-6	4-6	4-6	6-9
BANK COVER	0	2-6	2-6	4-9	6-9	6-9	6-9
THERMAL CONTROL	0	0-3	3-9	6-9	9	9	9
BANK STABILITY	0	3-6	6-9	6-9	9	9	6-9
SEDIMENT TRAPPING	0	3-9	3-6	3-6	6-9	6-9	9
SOLAR INPUT	9	6-9	0-6	0-3	0	0	0
TOTAL	11-12	18-44	21-49	28-52	45-56	46-57	50-60

CONTRIBUTION X IMPORTANCE = RELATIVE HABITAT QUALITY

CONTRIBUTION	IMPORTANCE
0 - none	0 - none recognized
1 - low	1 - low
2 - medium	2 - medium
3 - high	3 - high

1/ See text for explanation of matrix.

jsrfw2s

MATRIX 11. FISH HABITAT QUALITY RELATIVE TO SUCCESSIONAL STAGES OF RIPARIAN VEGETATION 1/

(TYPE 4 STREAM)

HABITAT COMPONENT	devegetated	grass-forb-shrub	pole-sapling-young/conif.	pole-sapling-young/hdwd	mature/conif	mature/hdwd	old growth
WOODY DEBRIS	0	0-3	3-9	3-9	9	9	9
ORGANIC LITTER	0	0-3	3-6	6	7.5	9	7.5-9
TERRESTRIAL INVERTEBRATES	1	2-3	1	1-2	2	2	3
BANK COVER	0	0	0	0	0	0	0
THERMAL CONTROL	0	0-9	9	9	9	9	9
BANK STABILITY	0	3-6	6-9	6-9	9	9	6-9
SEDIMENT TRAPPING	0	3-9	3-6	3-6	6-9	6-9	9
SOLAR INPUT	0	0	0	0	0	0	0
TOTAL	1	8-33	25-40	28-41	42.5-45.5	44-47	43.5-48

CONTRIBUTION X IMPORTANCE = RELATIVE HABITAT QUALITY

CONTRIBUTION	IMPORTANCE
0 - none	0 - none recognized
1 - low	1 - low
2 - medium	2 - medium
3 - high	3 - high

1/ See text for explanation of matrix.

MATRIX 12. FISH HABITAT QUALITY RELATIVE TO SUCCESSIONAL STAGES OF RIPARIAN VEGETATION 1/

(TYPE 5 STREAM)

HABITAT COMPONENT	devegetated	grass-forb-shrub	pole-sapling-young/conif.	pole-sapling-young/hdwd	mature/conif	mature/hdwd	old growth
WOODY DEBRIS	0	0-3	3-9	3-9	9	9	9
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	0	0	0	0	0	0	0
BANK COVER	0	0	0	0	0	0	0
THERMAL CONTROL	0	0-3	3	3	3	3	3
BANK STABILITY	0	3-6	6-9	6-9	9	9	6-9
SEDIMENT TRAPPING	0	2-6	2-4	2-4	4-6	4-6	6
SOLAR INPUT	0	0	0	0	0	0	0
TOTAL	0	5-19	15-27	16-27	27.5-29.5	28-30	26.5-30

CONTRIBUTION X IMPORTANCE = RELATIVE HABITAT QUALITY

CONTRIBUTION	IMPORTANCE
0 - none	0 - none recognized
1 - low	1 - low
2 - medium	2 - medium
3 - high	3 - high

1/ See text for explanation of matrix.

MATRIX 13. FISH HABITAT QUALITY RELATIVE TO SUCCESSIONAL STAGES OF RIPARIAN VEGETATION 1/

(TYPE 1 LAKE, POND, RES.)

HABITAT COMPONENT	devegetated	grass-forb-shrub	pole-sapling-young/conif.	pole-sapling-young/hdwd	mature/conif	mature/hdwd	old growth
WOODY DEBRIS	0	0	0-2	0-2	1-4	1-4	3-6
ORGANIC LITTER	0	0-1	1-2	2	2.5	3	2.5-3
TERRESTRIAL INVERTEBRATES	1-2	2-6	1-2	1-4	2-4	2-4	4-6
BANK COVER	0	0	1-4	1-6	3-6	3-6	3-6
THERMAL CONTROL	0	0	0	0	0	0	0
BANK STABILITY	0	2-4	4-6	4-6	6	6	4-6
SEDIMENT TRAPPING	0	1-3	1-2	1-2	2-3	2-3	3
SOLAR INPUT	3	3	3	3	3	3	3
TOTAL	4-5	8-17	11-21	12-25	19.5-28.5	20-29	22.5-33

CONTRIBUTION X IMPORTANCE = RELATIVE HABITAT QUALITY

CONTRIBUTION	IMPORTANCE
0 - none	0 - none recognized
1 - low	1 - low
2 - medium	2 - medium
3 - high	3 - high

1/ See text for explanation of matrix.

MATRIX 14. FISH HABITAT QUALITY RELATIVE TO SUCCESSIONAL STAGES OF RIPARIAN VEGETATION [1/]

(TYPE 2 LAKE, POND, RES.)

HABITAT COMPONENT	devegetated	grass-forb-shrub	pole-sapling-young/conif.	pole-sapling-young/hdwd	mature/conif	mature/hdwd	old growth
WOODY DEBRIS	0	0	0-6	0-6	6-9	6-9	9
ORGANIC LITTER	0	0-3	3-6	6	7.5	9	7.5-9
TERRESTRIAL INVERTEBRATES	2	4-6	2	2-4	4	4	6
BANK COVER	0	0	2-4	4-6	6	6	6
THERMAL CONTROL	0	0	0-3	0-3	0-3	0-3	0-6
BANK STABILITY	0	1-2	2-3	2-3	3	3	2-3
SEDIMENT TRAPPING	0	3-9	3-6	3-6	6-9	6-9	9
SOLAR INPUT	3-6	3-6	2-6	2-6	2-6	2-6	1-4
TOTAL	5-8	11-26	14-36	19-40	34.5-47.5	36-49	40.5-52

CONTRIBUTION X IMPORTANCE = RELATIVE HABITAT QUALITY

CONTRIBUTION	IMPORTANCE
0 - none	0 - none recognized
1 - low	1 - low
2 - medium	2 - medium
3 - high	3 - high

1/ See text for explanation of matrix.

MATRIX 15. FISH HABITAT QUALITY RELATIVE TO SUCCESSIONAL STAGES OF RIPARIAN VEGETATION 1/

(TYPE 3 LAKE, POND, RES.)

HABITAT COMPONENT	devegetated	grass-forb-shrub	pole-sapling-young/conif.	pole-sapling-young/hdwd	mature/conif	mature/hdwd	old growth
WOODY DEBRIS	0	0	0-6	0-6	6-9	6-9	9
ORGANIC LITTER	0	0-3	3-6	6	7.5	9	7.5-9
TERRESTRIAL INVERTEBRATES	3	6-9	3	3-6	6	6	9
BANK COVER	0	0	3-6	6-9	9	9	9
THERMAL CONTROL	0	0	3-6	6-9	9	9	9
BANK STABILITY	0	3-6	6-9	6-9	9	9	6-9
SEDIMENT TRAPPING	0	3-9	3-6	3-6	6-9	6-9	9
SOLAR INPUT	3-6	3-6	0-6	0-6	0-4	0-4	0-4
TOTAL	6-9	15-33	21-42	30-57	52.5-62.5	45-64	58.5-67

CONTRIBUTION X IMPORTANCE = RELATIVE HABITAT QUALITY

CONTRIBUTION	IMPORTANCE
0 - none	0 - none recognized
1 - low	1 - low
2 - medium	2 - medium
3 - high	3 - high

1/ See text for explanation of matrix.

APPENDIX C

LIST OF FOREST PRACTICES RULES AND REGULATIONS WHICH MAY ADDRESS RIPARIAN ECOSYSTEMS

FOREST PRACTICES RULES AND REGULATIONS

RELATED TO RIPARIAN HABITAT MANAGEMENT

MARCH 22, 1983

PREPARED FOR

RIPARIAN HABITAT TECHNICAL COMMITTEE

BY

FORESTRY SUBCOMMITTEE

WAC 222-12-090 Forest practices board manual. When approved by the board the manual serves as an advisory technical supplement to these forest practices regulations. The department, in cooperation with the departments of fisheries, game, agriculture, ecology, and such other agencies as may have appropriate expertise, is directed to prepare, and submit to the board for approval, a Forest Practices Board Manual. The manual shall include:

(1) Temperature sensitive determinations needed for use with WAC 222-16-040.
(2) Procedures for leaving the required 50 percent or 75 percent shade as required in WAC 222-30-040.
(3) A list of "key wildlife habitats" as established under WAC 222-16-010(23).
(4) The standard methods for measuring channel width, stream gradient and flow which are used in the water typing criteria WAC 222-16-030.
(5) A chart for establishing recommended permanent culvert sizes and associated data.
(6) Guidelines for clearing slash and debris from Type 4 Waters.
(7) Guidelines for landing location and construction.
(8) Aerial chemical application guidelines for requiring untreated strips on Type 4 Waters.

WAC 222-16-010 General definitions.
(48) "Streamside management zone" means a specific area alongside natural waters where specific attention must be given to the measures, that can be taken to protect water quality. These zones shall be measured from the ordinary high-water mark of the body of water and measure:
(a) 50 feet in width on each side of a Type 1 and 2 Water.
(b) 25 feet in width on each side of a Type 3 Water.

WAC 222-16-020 Water categories. The following types of water are used in these regulations, the system for typing the waters is as set forth in WAC 222-16-030 Water typing system.
(1) "Type 1 Water" means all waters, within their ordinary high-water mark, as inventoried as "shorelines of the state" under chapter 90.58 RCW.
(2) "Type 2 Water" shall mean segments of natural waters which are not classified as Type 1 Water and have a high use and are important from a water quality standpoint for:
(a) Domestic water supplies,
(b) Public recreation,
(c) Fish spawning, rearing, or migration or wildlife uses; or
(d) Are highly significant to protect water quality.
(3) "Type 3 Water" shall mean segments of natural water which are not classified as Type 1 or 2 Water and have a moderate to slight use and are moderately important from a water quality standpoint for:
(a) Domestic use,
(b) Public recreation,
(c) Fish spawning, rearing, or migration or wildlife uses; or
(d) Have moderate value to protect water quality.
(4) "Type 4 Water" shall mean segments of natural waters which are not classified as Type 1,2 or 3. Their significance lies in their influence on water quality downstream in Type 1, 2 and 3 Waters. These may be perennial or intermittent.
(5) "Type 5 Water" means all other waters, in natural water courses, including streams with or without a well-defined channel, areas of perennial or intermittent seepage, ponds, and natural sinks. Drainage ways having short periods of spring runoff are considered to be Type 5 Waters [Order 263, § 222-16-020, filed 6/16/76.]

WAC 222-61-050 Classes of forest practices. (1) "Class IV - Special." Application to conduct forest practices involving the following circumstances requires an environmental checklist in compliance with the state environmental policy act (SEPA), and SEPA guidelines, *(a) Aerial application of pesticides to an "area of water supply interest" as determined according to WAC 222-38-020(4)(h). *(e) Construction of roads, landings, rock quarries, gravel pits, borrow pits, and spoil disposal areas when conducted on excessively steep slopes or slide prone areas as defined in WAC 222-24-060(6) when such slopes or slide prone areas occur on an uninterrupted slope within 1,000 feet above a Type 1, 2, 3, or 4 Water where there is potential for a substantial debris flow or debris torrent to cause significant impact to fisheries habitat or public capital improvement.

WAC 222-16-050 Classes of forest practices. There are 4 classes of forest practices created by the act.
(5) "Class III" forest practices not listed under Classes IV, I or II above are Class III" forest practices. Among Class III forest practices are the following:
(a) Those requiring hydraulic project approval (RCW 75.20.100).
(b) Those within the shorelines of the state other than those in a Class I forest practices.
(h) Road maintenance involving:
(i) Replacement of bridges or culverts across Type 1, 2, 3, or flowing Type 4 Waters; or
(ii) Movement of material that has a direct potential for entering Type 1,2,3 or flowing Type 4 Waters.

WAC 222-30-020 Harvest unit planning and design.
*(4) Streamside management zone. Harvest units shall be designed so that felling, bucking, yarding or skidding, and reforestation can be accomplished in accordance with these regulations, including those regulations relating to stream bank integrity and temperature control. Where the need for additional actions or restrictions adjacent to waters not covered by the following become evident, WAC 222-12-050 and 222-12-060 may apply.

(6) Wildlife habitat. This section is designed to encourage timber harvest practices that would protect wildlife habitats, provided, that such action shall not unreasonably restrict landowners action without compensation.
(a) The applicant should make every reasonable effort to cooperate with the department of game to identify key wildlife habitats as defined by the board. Where these habitats are known to the applicant, they shall be identified in the application or notification.
(b) Where a key wildlife habitat has been identified the applicant shall consider reasonable means of protection thereof as part of the proposed harvesting operation.
(c) Harvesting methods and patterns in established big game winter ranges should be designed to insure adequate access routes and escape cover where practical.
(i) Where practical, cutting units should be designed to conform with topographical features.

(ii) Where practical on established big game winter ranges, cutting units should be dispersed over the area to provide cover, access for wildlife, and to increase edge effect.
(d) In areas where this will not create a significant fire or safety hazard nor conflict with achieving conformance with the limitation of or performance with the provisions of chapter 76.04 RCW (snag falling law) and chapter 49.17 RCW (safety), a reasonable number of snags will be left to protect habitat for cavity nesting wildlife. [Order 263, § 222-30-020, filed 6/16/76.]

WAC 222-30-030 Stream bank integrity. *In the streamside management zone along all Type 1,2 and 3 Waters, use reasonable care to:
(1) Avoid disturbing brush and similar understory vegetation;
(2) Avoid disturbing stumps and root systems;
(3) Leave high stumps where necessary to prevent felled and bucked timber from entering the water.
The streamside management zone is measured from the ordinary high-water on both sides of the water and is 50 feet in width for Type 1 and 2 Waters and 25 feet for Type 3 Water. [Order 263 § 222-30-030, filed 6/16/76.]

WAC 222-30-04 Temperature control. *(1) Determination of temperature sensitivity for Type 1, 2 and 3 Waters shall be based upon field data or upon criteria set forth in WAC 222-16-040. Any designation as to whether or not waters are temperature sensitive shall be made by the department prior to the deadline for approval or disapproval of the application for harvest.
*(2) Shade requirements. Within the streamside management zone along those Type 1, 2 and 3 Waters designated as temperature sensitive, unless a waiver is granted by the department under subsection (3) of this section, the operator shall:
(a) Leave all nonmerchantable vegetation which provides mid-summer and mid-day shade of the water surface; and
(b) Leave sufficient merchantable timber, if any, necessary to retain 50 percent of the summer mid-day shade of the water surface, provided that the department shall require leaving 75 percent of the shade where it determines that the mean of the maximum summer daily ambient water temperatures, for a 7-day period, exceeds 60 degrees before logging. (See the Forest Practices Board Manual Part 2 for methods of shade (determination.)
*(3) Waivers. The department may waiver or modify the shade requirements where the applicant:
(a) Shows a high probability of windthrow and agrees to replant the streamside management zone within the first planting season after harvest; or
(b) Agrees to a staggered setting program producing equal or greater temperature control; or
(c) Provides alternative means of stream temperature control satisfactory to the department.

WAC 222-30-050 Felling and bucking. *(1) Felling into stream.
(a) No trees will be felled into Type 1, 2 and 3 Waters, except trees which cannot practically and safely be felled outside the stream, lake or pond using techniques in general use and these trees must then be removed promptly.
(b) Trees may be felled into Type 4 Water if logs are removed as soon thereafter as practical.
*(2) Bucking in streams.
(a) No bucking or limbing shall be done on trees or portions thereof lying between the banks of Type 1, 2 and 3 Water, except as necessary to remove the timber from the stream, lake or pond.
(b) Where bucking or limbing is done between the banks of a Type 4 Water, care shall be taken to minimize accumulation of slash in the stream, lake or pond.
*(3) Felling in streamside management zones.
(a) Individual trees within a streamside management zone otherwise restricted from cutting may be harvested if reasonably expected to fall into the stream, lake or pond from natural causes.
(b) Care shall be taken to fall any trees cut within the streamside management zone in a manner to prevent damage to the stream, lake or pond and streamside management zone.
*(4) Felling near streamside management zone and setting boundaries. Reasonable care shall be taken to avoid felling trees into steamside management zones and areas outside the harvest unit.

WAC 222-30-060 Cable yarding. *(1) Type 1, 2 and 3 Water. No timber shall be cable yarded in or across a Type 1, 2 and 3 water except where.
(a) The logs will not materially damage the stream bed, banks or streamside management zone; or
(b) Necessary to remove trees from the stream; or

(c) Part of a stream clearance and improvement project approved by the departments of fisheries or game; or
(d) Approved by the department.
*(2) Deadfalls. Any logs which are firmly embedded in the bed of a Type 1, 2 or 3 Water shall not be removed or unnecessarily disturbed without approval of the departments of fisheries and game.
*(3) Yarding in streamside management zone. Where timber is yarded from or across a streamside management zone, reasonable care shall be taken to minimize damage to the vegetation providing shade to the stream. Where practical and consistent with good safety practices, logs shall be yarded in the direction in which they lie until clear of the streamside management zone.
(4) Direction of yarding.
(a) Uphill yarding is preferred.
(b) Where downhill yarding is used, reasonable care shall be taken to lift the leading end of the log to minimize downhill movement of slash and soils.
*(c) When yarding parallel to a Type 1, 2 or 3 Water channel below the 25-year flood level, reasonable care shall be taken to minimize rutting and to prevent logs from rolling into the stream, lake or pond or streamside management zone.

WAC 222-30-070 Tractor and wheeled skidding systems. *(1) Streams
(a) Tractor and wheeled skidders shall not be used in Type 1, 2 or 3 Water, except with the approval of the department.
(b) Skidding across any flowing Type 4 Water shall be minimized and when done, temporary stream crossings shall be used, if necessary, to maintain stream bed integrity.
(c) When ever skidding in or across any type water, the direction of log movement between stream banks shall be as close to right angles to the stream channel as is practical.
*(2) Streamside management zone. (a) Logging will be permitted within the zone, provided that tractors and wheeled skidders may not be used within the zone unless approved by the department.
(b) Where skidding in or through the streamside management zone is necessary, the number of skidding routes through the management zone shall be minimized.
(c) Logs shall be skidded in the direction in which they lie until clear of the streamside management zone, to the extent practical and consistent with good safety practices.
(3) Deadfalls. Any logs which are firmly embedded in the bed of a Type 1, 2 or 3 Water shall not be removed or unnecessarily disturbed without approval of the departments of fisheries and game.

WAC 222-30-100 Slash disposal.
*(4) Removing slash and debris from streams.
(a) "Slash" or "debris" which can reasonably be expected to cause significant damage to the public resource shall be removed from Type 1, 2 or 3 Waters, to above the 25-year flood level and left in a location or manner minimizing risk of re-entery into the stream, lake or pond and if substantial accumulations of slash disposal is required.
(b) "Slash" and "debris" shall be removed from below the ordinary high-water mark of Type 4 Waters, when the department issues written notice for removal of the slash or debris because of potential damage to public resources. See Part 6 of the Forest Practices Board Manual for "Guidelines for Clearing Slash and Debris from Type 4 Waters."

WAC 222-34-040 Site preparation and rehabilitation.
(3) Stream channel alignment. Where work involves deepening, widening, straightening or relocating the channel; or bulkheading, riprapping or otherwise stabilizing the banks of a Type 1, 2 or 3 Water, the work shall be done only:
(a) After consultation with any party having an appropriation permit or registered right to appropriate waters from the affected stream segment in cases of streams used for domestic water supplies.
(b) Where no significant adverse affects on either the peak or minimum water levels or flows downstream can be expected.
(c) In a manner not expected to result in long-term damage to public resources or to adjacent or downstream property. (NOTE: OTHER LAWS AND REGULATIONS AND/OR PERMIT REQUIREMENTS MAY APPLY. SEE CHAPTER 222-50 WAC.)

WAC 222-38-020 Handling, storage, application. (Forest Chemicals)
*(4) Aerial application.
(a) Leave at least 50 feet untreated on each side of all Type 1 and 2 Water and other areas of open water, such as ponds or sloughs or leave 25 feet untreated on each side of Type 3 Waters.
(b) Leave at least 25 feet untreated on each side of flowing Type 4 Waters when required by the department. The department may so require when there is a likelihood of unreasonable impact on:
(ii) Streams or segments of streams which have been identified by the department of game or the department of fisheries as serving artificial fish rearing or incubation facilities.
See Part 8 of the forest practices board manual for guidelines for requiring untreated strips on Type 4 Waters.
(c) Where practical, apply the initial swath parallel to the untreated zones in subsection (4)(a) of this section on Type 1,2 or 3 Waters.
(d) Use a bucket or spray device capable of immediate shutoff.
(e) Shut off chemical application during turns and over open water.
(f) Avoid direct entry of chemicals into any Type 1 or flowing Type 2 or 3 Waters or those Type 4 Waters identified in subsection (b) of this section.
(g) The landowner shall identify for the operator the units to be sprayed and the untreated areas within the units so they are visible from the air. Before application of the chemical an over-flight of the area shall be made by the pilot and a responsible agent of the landowner.
*(5) Stream protection - ground application with power equipment.
(a) Leave at least 10 feet untreated on each side of every Type 1 and 2 Water and each flowing Type 3 Water.
(b) Avoid direct entry of chemicals into any water.
(c) Avoid exceeding intended or allowable dosages.
*(6) Stream protection - hand application.
(a) Apply only to specific targets, such as a stump, burrow, bait or trap.
(b) Keep chemicals out of all water.

WAC 222-42-010 Supplemental directives. (1) Purpose of supplemental directives. The department may issue supplemental directives to the forest landowner, timber owner and operator, advising them to take or not take as part of any forest practice operations specified actions the department determines to be preferred courses of action or minor changes in the operation to provide greater assurance that the purposes and policies set forth in RCW 76.09.010 of the act will be met.

WAC 222-50-020 Other agency requirements.
(2) Hydraulics project approval law, RCW 75.20.100. A hydraulics project approval must be obtained from the department of fisheries and the department of game prior to constructing any form of hydraulic project or other work that will use, divert, obstruct, or change the natural flow or bed of any river or stream or that will utilize any of the waters of the state or materials from the stream beds. See RCW 75.20.100 and WAC 232-12-655.
(3) Compliance with the Shoreline Management Act, chapter 90.58 RCW, is required. The Shoreline Management Act is implemented by the department of ecology and the applicable local governmental entity. A substantial development permit must be obtained prior to conducting forest practices which are "substantial developments" within the "shoreline" area as those terms are defined by the Shoreline Management Act.
Forest Practices Board Manual
(1) Temperature Sensitive Determination

Estimation of Topographic Shading

Topography may shade certain potentially temperature sensitive waters. Those waters where topographic shading prevent sunlight from reaching the water surface may be exempt from the vegetative shading requirements. See WAC 222-16-040 and 222-30-040.

Streams flowing east-west in steep canyons will often be shaded by topographic features such as steep ridges or bluffs. The presence of topographic shading is dependent on sun angle and side slope steepness. To determine whether sunlight will reach a given body of water, project a straight line from the opposite side of the streambed to the top of the ridge line or bluff. If the slope of the resulting line is 57 degrees (155 percent) or greater, topographic shading may be assumed along that reach of stream immediately below the ridge. See Figure 1.

Beaver Ponds

Beaver ponds are important habitat for fur bearers, raptors, various species of nongame birds, and some types of fish. Beaver ponds should be identified on the forest practice application. The applicant should consult with the Departments of Fisheries and Game to determine whether removal of a particular beaver dam would produce net benefits or detriments to fish and wildlife, and whether any such net benefits justify foregoing any gains in timber productivity which could be achieved by removal of the dam.

Snags

The falling of snags is regulated by RCW 76.04.222 (Snag Falling Law), Chapter 49.17 RCW, WAC 332-24-020, -25 and -027, and other applicable worker safety regulations. Snags furnish essential nesting and/or feeding habitat for many species of birds and small mammals. Any snags not required to be cut by WAC 332-24-027, or other fire or worker safety regulations may be left standing. Also decadent or deformed live trees with little commercial value may be retained. Large (30-inch) snags surrounded by patches of old growth timber provide habitat for the uncommon pileated woodpecker. For optimum habitat, 6 snags per acre may be preserved where consistent with fire and safety regulations. Snags left adjacent to water can provide important habitat.

Big Game Winter Ranges

Big game animals are scattered throughout the State so it is impossible to accurately delineate all big game winter ranges. In many key wintering areas of eastern Washington, logging during the winter months is beneficial to big game since the succulent tops and lichens from freshly felled trees are an important food source during the critical winter periods. In western Washington, clearcuts dispersed over the winter range area provide forage adjacent to shelter and escape cover. The edge or ecotone between 2 vegetative types always supports a greater variety of wildlife species than does either type alone. Clearcuts create "edge" effect, thus creating desirable wildlife habitat.

Streamside Management Zones

These areas are designed primarily for the protection of water quality and fishery resources, but they can also be important habitat for wildlife. More than 60 species of birds and animals depend on riparian habitat for a significant portion of their existence, while a greater number of other species utilize these streamside areas during some portion of their life span. Creek bottoms are natural travel corridors for both large and small animals and, if vegetative cover is left along the stream, these travel routes will not be disrupted by the removal of timber. Streamside management zones may be particulary appropriate places to leave snags.

(6) GUIDELINES FOR CLEARING SLASH AND DEBRIS FROM TYPE 4 WATER

WAC 222-30-100(4)(b) provides that the Department of Natural Resources may require removal of "slash" and "debris" from below the ordinary high-water mark of Type 4 Water when there is potential for damage to public resources.

The major emphasis of all Forest Practices Regulations is to prevent problems before they occur. This cannot be emphasized strongly enough in the case of slash and debris in Type 4 Water. Preventative measures to keep material out of all streams will go a long way toward solving potential problems. Therefore, stream cleanout should be viewed as a "backup" or supplement to preventative measures such as those described in WAC 222-30-050(2)(b), providing that care shall be taken to minimize accumulation of slash where bucking or limbing must be done between the banks of a Type 4 Water.

The reason for keeping slash and debris out of Type 4 Water is to prevent it from compounding the problems caused by any mass failure on the adjacent and upstream sideslopes. Current research indicates that "slash" and "debris" in Type 4 Water do not trigger mass soil movement. However, where mass failure of sideslope occurs for other reasons, an accumulation of slash and debris in the channel can increase the amount of environmental damage if it moves into downstream Type 1, 2, and 3 Waters or reaches a capital improvement. Therefore, these guidelines are structured around the concept that removal generally will be required wherever there is sufficient potential for mass failure resulting in such downstream damage.

Refer to page 19 of the manual for more explanation.

(8) AERIAL CHEMICAL APPLICATION GUIDELINES FOR REQUIRING UNTREATED STRIPS ON TYPE 4 WATERS

This guideline is to be used with "Aerial Applications" WAC 222-38-020(4)(b).

Untreated strips at least 25 feet wide on each side of flowing Type 4 Waters may be required when certain water intakes or identified fish incubation or rearing facilities are present and the Department of Natural Resources determines:

1. The intakes or facilities are exposed to direct application or physical drift of chemical, or,

2. A study of the area to be treated and technical advice of the Department of Social and Health Services and the Department of Agriculture indicate a likelihood of unreasonable chemical impacts on water flowing into the intakes or the facilities.

APPENDIX D

RIPARIAN HABITAT STUDY WORKPLAN

DECEMBER, 1982

FISH AND WILDLIFE HABITAT REQUIREMENTS
IN FORESTED RIPARIAN ECOSYSTEMS

Revised Study Plan
December 1982

INTRODUCTION

Riparian areas involve the narrow band of vegetation and soils bordering all surface waters -- including streams, lakes, reservoirs, and tidelands. They are the interface between aquatic and terrestrial environments. Riparian areas are identified as rich and diverse environments where many vegetation edge effects, abundant surface and ground water, and lush plant growth distinguish them from upland areas.

Three important factors differentiate riparian habitats and contribute to their productivity: (1) the presence of surface water; (2) complex and diverse vegetation which creates ground, shrub, and canopy habitats in one area; and (3) riparian areas border or interconnect with other upland habitats allowing access to other habitats and to water. Biologists have determined that riparian conditions are critical to the stability of many fish and wildlife species and that some wildlife species are present only in riparian areas.

Public concern regarding riparian area management and its effects on fish and wildlife populations surfaced during public hearings held in 1981 to consider forest practices regulation changes (Forest Practices Board, Final EIS, June, 1982). Forest Practices Board (Board) deliberation on this issue revealed, however, that sufficient evidence was not available to warrant changes in the Forest Practices Rules and Regulations at that time.

As a result, the Board directed that a Riparian Habitat Study be conducted (Board minutes; March 31, 1982). The study was to be a technical examination of fish and wildlife habitat requirements in riparian areas. The Board chose to delay action on considering regulations until the Riparian Habitat Study findings became available (Board minutes; June 24-25, 1982).

The Board made the March 1982 study directive with the understanding that an opportunity would be provided to review the study plan. Since that time, a technical committee was formed, preliminary work initiated and study plan proposed. On November 16, 1982 the Board reviewed the study plan and provided additional clarification and direction to the study. Board concerns included:

1. That a broad-based review of available information be conducted to determine the biological relationships between fish and wildlife and the elements of their forest riparian habitats;

2. Upon determination that sufficient biological information is available, that a determination be made of those beneficial and detrimental changes, or trade offs, caused by forest management activities;

3. If such changes cannot be adequately determined, that information needs be identified for future study;

4. If such changes can be determined, that methods be identified to reduce adverse changes; and

5. That the study be separated into two phases whereby the first phase consider the biological relatinships of concern and the second phase examine forest practices to manage adverse changes.

This paper presents revisions to the preliminary study plan based upon the Board's concerns. Outlined below are the goals, objectives, scope, definitions, and major steps of the Riparian Habitat Study. It should be noted that no specific funding has been provided to carry out the study. This places certain limitations on the technical committee and study. Limitations are described in the Scope of Study section.

Study Goals

The overall goals of this study are to:

1. Conduct a technical examination of fish and wildlife habitat requirements in riparian areas;

2. Identify changes in riparian habitat -- beneficial, detrimental, or tradeoffs -- which occur as a result of current forest practice; and

3. Identify practices available to reduce or prevent detrimental changes in riparian habitat.

In all cases, forest practices are presumed to be conducted in compliance with Washington State Forest Practices Rules and Regulations (Ch. 222 WAC).

Study Objectives

Specific study objectives are to:

1. Determine the characteristics and uses of forest land riparian habitats in Washington.

2. Inventory existing conditions, including the types and extent of riparian habitats occurring and changes in riparian habitats caused by forest practices.

3. Evaluate the changes in riparian habitat and determine whether such changes are beneficial or detrimental to fish and wildlife uses of riparian habitat.

4. For those detrimental changes, identify practices and procedures available to reduce or prevent such detrimental changes.

5. Report findings to the Forest Practices Board members for their deliberation.

Scope

This study will address the following resources:

1. <u>Forest lands</u>, those nonfederal lands in Washington State capable of supporting merchantable stands of timber and not being used for incompatible activities, such as farmlands or urbanized areas.

2. <u>Water bodies</u>, those streams, rivers, ponds, lakes, reservoirs, and tidewaters considered Type 1, 2, 3, 4, or 5 waters in WAC 222-16;

3. Fish, including anadromous and resident salmonids, spiny rays, and all others; and

4. Wildlife, including mammals, birds, reptiles, and amphibians. Aquatic and terrestrial insects are recognized as a significant food source for fish and wildlife, but are not included as wildlife as used in this study.

The absence of specific funding places limitations on the level of investigation. Findings will be based upon information available in the research literature and from the management programs of public and private organizations. A minimum amount of field study is scheduled.

Many relationships between fish and wildlife and their riparian habitat are relatively complex and research information has become available only in recent years. For example, life history descriptions for some wildlife species may not indicate the level of dependency upon riparian habitat. When the technical committee must rely on assumptions, or when information gaps appear, these will be clearly identified. Other constraints will be identified as they develop.

Definitions
(See Figure 1)

Aquatic Zone -

The area below the mean annual high water mark of surface waters including the water, banks, beds, organic and inorganic constituents.

Riparian Zone -

The area bordering streams, lakes, tidewaters and other bodies of water. Riparian zones are transitional areas which lie between aquatic and terrestrial environments. They have high water tables and may contain plants which require saturated soils during all or part of the year.

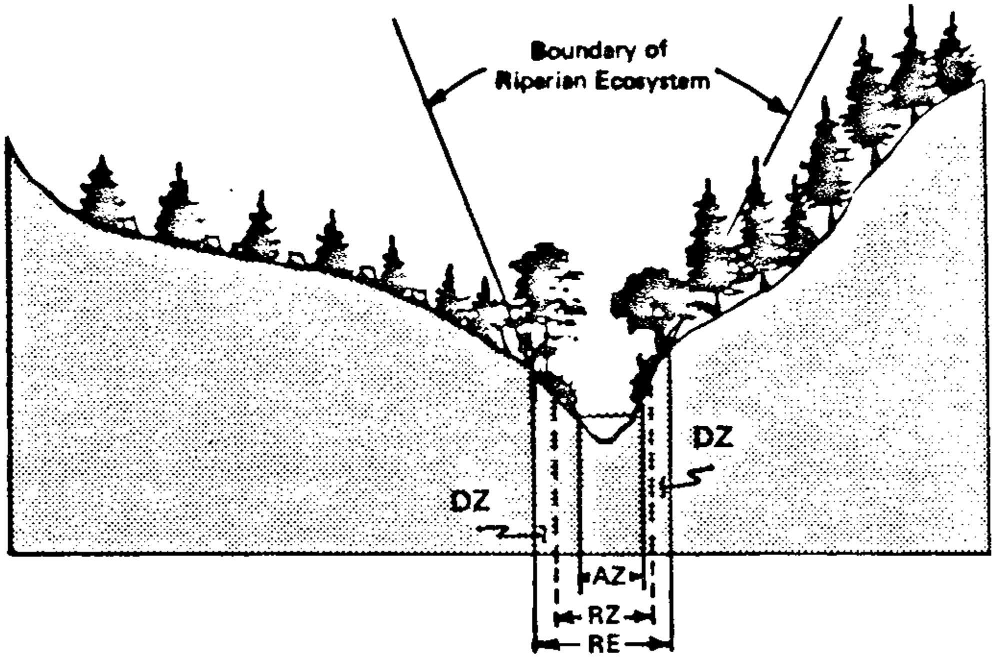
Direct Influence Zone -

The zone located adjacent, but outside the riparian zone containing vegetation which directly shapes the physical structure of the aquatic environment, or contributes organic material to aquatic and riparian zones through the forces of gravity or wind.

Riparian Ecosystem -

The area bordering streams, lakes, tidewaters, and other bodies of water which include elements of the aquatic and terrestrial ecosystems. They have a high water table and may contain plants which require saturated soils during all or part of the year. Riparian ecosystems include aquatic and adjacent terrestrial areas which directly influence the quality of fish and wildlife habitat.

Figure I. BOUNDARIES OF A RIPARIAN ZONE AND RIPARIAN ECOSYSTEM



Riparian Zones (RZ) include the Aquatic Zone (AZ) and the stream adjacent area with high water table and may contain plants which require saturated soils at least part of the year. Riparian Ecosystems (RE) include the Riparian Zone, Aquatic Zone and the vegetation which can directly influence aquatic and riparian habitat - the Direct Influence Zone (DZ).

Adopted from Meehan and others (1977).

Description of Tasks

The Riparian Habitat Study is separated into two phases: Phase I (Steps 1 through 6) includes the biological investigations necessary to determine fish and wildlife uses of riparian habitat and identify changes in habitat type and use which occur due to forest practices; Phase II (Steps 7 through 10) includes identification and analysis of forest management practices which can reduce or prevent detrimental changes in habitat. At the completion of Phase I the technical committee will submit an interim report of findings to the Forest Practices Board. The Board will then review the interim report to determine the need for further study. Further study may include: a) development and completion of supportive investigations to fill critical data gaps; or, b) based upon findings of Phase I, proceeding directly to Phase II as described herein.

A Board decision to proceed to Phase II will entail restructuring of the existing technical committee to acquire expertise in such fields as forest management, forest engineering, and economics.

The nine major steps involved in both Phases I and II and described below. Relationships between major steps and study objectives are presented (Table 1) and a schedule of tasks is proposed (Figure 2).

RIPARIAN HABITAT STUDY - DESCRIPTION OF MAJOR STEPS

Phase I

Step 1. Establish Riparian Habitat Technical Committee (RHTC)

Purpose: To acquire the services and expertise of individuals needed to conduct study.

Outputs: Establish working committee with expertise in fish and wildlife biology, forest management, forest hydrology, and water quality. Members will represent public, private industry, government resources agencies, and Indian nations.

Forest Practices (FP) Board Decision Point: Concurrence with composition of RHTC.

Estimated Completion Date: May 31, 1982

Step 2. Develop Background Information; Describe Riparian Areas

Purpose: To identify information needs and sources of available information; to develop common understanding of the characteristics of riparian areas.

RHTC Activities: Identify information needs and available sources (e.g. research literature, agency and industry resource inventories and management programs)
Describe riparian areas - location, structure, functions.
Define terms.
Determine scope of study including geographic, water bodies, land use, fish and wildlife.

Outputs: Definitions, preliminary scope of study.

Estimated Completion Date: August 31, 1982.

Step 3. Develop Study Workplan

Purpose: To establish study objectives, scope, definitions, tasks, and schedule.

RHTC Activities: Prepare draft workplan.

Outputs: Draft workplan.

FP Board Decisions Point: Review and revise, as necessary, draft workplan. Take approval action to proceed with study.

Estimated Completion Date: Draft workplan from RHTC: October 15, 1982.
Directive to proceed: January 18, 1983.

Step 4. Identify Fish and Wildlife Uses of Habitat in Riparian Ecosystems.

Purpose: To identify the types and levels of uses of riparian habitat.

RHTC Activities: Based upon available information, determine species of fish and wildlife which use habitat in riparian ecosystems.
Identify riparian dependent species of wildlife, where possible.
Identify levels of use and preferred vs. required uses, where possible.
Identify characteristics of riparian habitat which distinguish it from other (upland) habitat types.

Outputs: Subcommittee reports detailing findings from above.
Prepare preliminary findings paper based upon Steps 2 and 4.

Estimated Completion Date: February 28, 1983.

Step 5. Classify Riparian Ecosystem Plant and Animal Communities. Identify Successional Stages of Plant Communities. Identify Associated Animal Communities.

Purpose: To provide a means of focusing study by grouping riparian vegetation, fish, and wildlife into communities which commonly occur.

To determine biological relationships between the type and structure of plant and animal communities in riparian ecosystems.

RHTC Activities: Examine available forest plant and animal inventories and classification systems.
Select or develop a riparian plant classification system(s) appropriate to scope and requirements of this study.

Examine available information regarding classification of forest succession.
Select successional classes most appropriate for scope and requirements of this study.
Identify, from available information, animal communities associated with each successional stage represented in selected classification.

Outputs: Selected classification systems and subcommittee reports.

Estimated Completion Date: Selection of plant/animal communities classification system; November 30, 1982. Successional stages and associated animal communities; February 28, 1983.

Step 6. <u>Identify Biological Changes in Plant/Animal Communities and Successional Stages Occurring as a Result of Forest Practices Presumed to be in Compliance with Forest Practices Rules and Regulations.</u>

Purpose: To identify relationships between forest practices/successional stages/type of habitat in riparian ecosystems.

RHTC Activities: Examine available information to identify the types of changes in riparian habitat caused by forest practices. Identify whether information is conclusive or indicates expected change. Identify relationships needing additional study.

Evaluate changes in habitat and assess biological impacts -- beneficial and detrimental -- on fish and wildlife. Include expected longevity and severity of biological impacts.

Conduct field studies, where possible, to verify changes in plant/animal communities and successional stages.

Prioritize changes relative to their biological significance.

Output: Report of findings from Steps 6 and 7. Interim technical report presenting methods and findings from Steps 2, 4, 5, 6, and 7.

FP Board Decision Point: Review interim technical report; based upon identified biological changes determine whether sufficient problems or opportunities for enhancement exist to proceed with study. If decision is to proceed, determine whether additional studies are needed to supplement available information or to proceed directly to Steps 7, 8, and 9. Proceed with Steps 7, 8, and 9 by restructuring existing RHTC; add, with FP Board concurrence, members having expertise to identify and develop alternatives practices to resolve detrimental changes.

Note: It is expected that a number of members of the original RHTC will end their participation in the committee at the completion of Step 6. Recommendations as to the type of expertise needed and candidates for the restrctured RHTC will be sought from original RHTC members.

Estimated Completion Date: Interim technical report; June 30, 1983.
FP Board decision to proceed: July 31, 1983.

PHASE II

Step 7 Verify Forest Practices or Specific Methods Causing Detrimental Changes in Habitat in Riparian Ecosystems.

Purpose: To focus on those forest practices causing problems.

RHTC-2 Activities: Based upon findings of Step 6, verify or refine practices causing detrimental changes in habitat. Conduct field studies, as necessary. Link specific practices with specific changes.

Outputs: Documentation of findings.

Estimated Completion Date: September 30, 1983.

Step 8 Identify and Assess Practices or Specific Methods to Reduce or Prevent Detrimental Changes in Habitat in Riparian Ecosystems.

Purpose: To identify alternative methods to provide additional protection of fish and wildlife habitat in riparian ecosystems for those forest practices resulting in detrimental changes.

To develop preliminary implementation procedures. To assess associated costs and benefits or practices identified to solve problems.

RHTC-2 Activities: Review available information to identify or develop alternative methods of reducing or mitigating detrimental changes. For example, alternative methods may include revised forest practices regulations or administrative procedures, information/education programs, or economic incentives. Conduct field studies, as necessary.

Identify procedures to implement alternative methods to reduce or prevent detrimental changes. Assess associated costs and benefits of each.

Outputs: Subcommittee reports describing; (a) alternative methods to reduce or prevent detrimental changes, (b) identified implementation procedures, and (c) associated cost and benefits of each method.

Estimated Completion Date: March 1, 1984.

Step 9. Prepare Final Report and Present Findings to Forest Practices Board

Purpose: To document study methods and findings, and submit findings to implementing agency -- Forest Practices Board.

RHTC-2 Activities: Prepare report of findings; report subject to review and approval of full technical committee.

Present findings to Forest Practices Board.

Outputs: Final report published as part of state agency (i.e. Dept. of Natural Resources and/or Dept. of Ecology) technical report series.

Estimated Completion Date: Final Report: April 30, 1984.
Publication and Distribution: June 30, 1984.
Presentation of Findings to Forest Practices Board: June 30, 1984.

APPENDIX E

WASHINGTON DEPARTMENT OF NATURAL RESOURCES

DRAFT FINAL GUIDELINES FOR RIPARIAN MANAGEMENT

ON STATE FOREST LANDS

DRAFT

Revised 11/15/84

RIPARIAN MANAGEMENT ZONE DRAFT FINAL GUIDELINES

The riparian ecosystem is defined as an area of transitional terrestrial environment bordering streams, lakes, tidewaters and other bodies of water. It includes banks, beaches and associated organic and inorganic constituents; flood plains; areas of high water table usually associated with plants which require saturated soils during all or part of the year; plus an area of indirect influence which directly shapes the physical structure of the aquatic environment and influences the quality of fish and wildlife habitat by contributing organic material, shade and buffering action.

The Department's Riparian Management Zone (RMZ), as defined on page 153 of the FLMP, shall be located within the riparian ecosystem of trust land waters typed as 1, 2 or 3 under Forest Practices Regulations. The management within this special zone shall be, as a first priority, directed toward meeting the needs of non-timber resources and habitats. Timber harvesting in the RMZ will be carried out only when adequate protection can be provided to these resources and habitats. The zone is to be established on a site specific basis as determined by the key resource to be protected and the needs of that resource. As a result, it will be variable in width, but not less than the legal requirement of the Forest Practices Act, shaped to blend in with the land form, withstand local climatic conditions and designed to meet the needs of the non-timber resource.

The Area will establish riparian management zones during the timber presales process and will prepare a site specific prescription for the management of this zone. A suggested organizational approach to preparing a RMZ management prescription is as follows:

DRAFT

An Organizational Approach to Preparing

A RMZ Management Prescription

1st STEP — VERIFY WATER-TYPE

2nd STEP — IDENTIFY SPECIFIC RESOURCE(S) FROM EACH RESOURCE GROUP(S)

(See Appendix A)

3rd STEP — IDENTIFY THE PROTECTION NEEDS OF EACH SPECIFIC RESOURCE

(See Appendix A)

4th STEP — SELECT THE KEY NON-TIMBER RESOURCE(S) WITH MOST RESTRICTIVE NEEDS

(See Appendix A)

5th STEP — DEVELOP SPECIFIC CONSIDERATIONS BY COVER-TYPE

(See Appendix B)

6th STEP — PREPARE A WRITTEN MANAGEMENT PRESCRIPTION

DRAFT

The management prescription will be in narrative form and attached to the regeneration plan in the timber presales packet. The prescription may include the following:

1. The objectives for the zone - key non-timber resources and habitats.

2. A needs assessment, standards and constraints for adequate protection of the objective.

3. The range of width of the zone and how determined.

4. A brief description of management activities by vegetational cover-type.

    - identify trees, other vegetation and detritus to be left
    - windthrow potential
    - harvest considerations

DRAFT

APPENDIX A

Appendix A: Identifying Site-Specific RMZ Objectives

NOTE: The first step before proceeding with the guidelines is the verification of the water types. There is an estimated 20 percent error in present mapping.

Successful management for the needs of nontimber resources within riparian management zones requires the ability to identify specific management objectives for these zones. Two things must be known to do this. First, the most important resources which require protection must be identified. Then, what is needed for their adequate protection must be determined. Adequate is used here to mean protection which will ensure that present animal populations or resource uses are maintained.

Specific resources are selected for the resource groups of fish, game and nongame animals, aesthetics and water quality. Selection is based on the presence of the resource, site conditions and resource use. In some cases, a resource group may have more than one important specific resource. In other cases, it may have none, and that particular group no longer needs to be considered.

Once the specific resources are selected from the resource groups, the needs for adequately protecting them should be evaluated. A second level of key resources is then selected on the basis of the needs evaluation. Resources selected will be those which require the most restrictive management option. The location of the riparian management zone and its management prescription will depend on the needs of these key resources.

Appendix A: Identifying Needs of a Resource Objective

Water Quality

Water quality is an aspect of the water resource which will usually be considered in the establishment of riparian management zones. To effectively evaluate the protection needs for water quality, the riparian ecosystem must be identified. The riparian ecosystem is very important hydrologically. They serve as the major source areas for storm flows. Because of the frequent saturated condition of the soils within the ecosystem, these areas can be susceptible to instability and severe soil compaction with disturbance. Unlike the terrestrial forest environment, overland flow is not uncommon and it can serve as a transport mechanism for sediment and other pollutants. Vegetation within the riparian ecosystem often is important for stabilizing banks and reducing velocities of flood flows in streams.

The needs for adequate water quality protection will depend, in part, on uses of the water resource. Water bodies important for fish habitat or used for water supplies will demand greater protection than those that are not. Water uses are incorporated to some extent in the water typing system of the Forest Practices Rules and Regulations. However, some consideration of local site conditions must also be used.

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There are three important considerations of the riparian ecosystem and its influences on the water body that should be incorporated into an evaluation of protection needs. These are:

1. The present stability of banks, stream channels, and the riparian ecosystem and the potential for instability because of disturbance.

2. The influence of the riparian vegetation on the thermal quality of water.

3. The effectiveness of the riparian ecosystem in filtering out sediment carried by overland flow before it reaches the water body.

Stability. The stability of banks, stream channels and the riparian ecosystem affects water quality in several ways. Banks which are eroded by wave action or stream currents are a major source of sediment. In many cases, deep rooted vegetation within the riparian ecosystem is the principal factor in maintaining bank stability. By maintaining bank stability and, in some cases supplying large organic debris, the riparian ecosystem influences the stability of stream channels. Unstable channels increase sediment and bed loads. The riparian ecosytem also helps stabilize channels by trapping floatable debris from upstream or upslope. Accumulation of debris within streams can cause excessive ponding behind debris dams. Sudden release of water or flow diversion can cause further instability. If the riparian ecosystem is unstable, it can also be a source of sediment when mass movements of soil into the water body occurs.

The assessment of bank, stream channel and riparian ecosystem stability may include the following considerations:

1. The capacity of a stream channel to handle high flows. A lower capacity indicates a greater frequency of flooding in the riparian ecosystem.

2. The rock content of banks and its effectiveness as a stabilizer.

3. The presence of flow obstructions such as large boulders and organic debris and their influences on flow diversion.

4. Whether or not bank erosion is taking place.

5. Gradient of the side slopes.

6. Potential for mass wasting within the riparian ecosystem.

7. The effectiveness of the vegetation within the riparian ecosystem for holding soil in place, preventing movement of debris, and reducing the velocity of flood flows.

More detailed descriptions of how to use these considerations for rating the stability of banks and the riparian ecosystem can be found in the Forest Service (1975) "Stream Reach Inventory and Channel Stability Evaluation" and the EPA (1980) "Approach to Water Resources Evaluation of Non-Point Silvicultural Sources."

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Thermal Quality. Maintaining thermal quality of water is important for protecting the biology of a water body. Not only are certain species sensitive to changes in water temperature, but temperature also directly influences the concentration of dissolved oxygen. The vegetation within the riparian ecosystem is often the principal source of shade from solar radiation. Removal of vegetation and exposing the water body to solar radiation can increase temperature under certain conditions.

Filtering. Overland flow does not commonly occur within the terrestrial forest environment. However, extreme disturbances of the forest soil such as roads, landings, fire trails, and skid trails can create conditions that will generate overland flow. If it is anticipated that overland flow from disturbances such as these will reach the riparian ecosystem, precautions should be taken to ensure that sediment will be filtered out before reaching the water body. Obstructions such as vegetation, stumps, and logs can reduce the flow velocity so that sediment is deposited. Litter on the forest floor can have a filtering effect. The width of the riparian management zone which will serve as an effective filter will vary with the gradient of the side slopes.

Fish Resource

Many of the protection needs of the fish resource coincide with the needs for protecting water quality. Measures which ensure thermal quality, prevent sediment from entering streams, and promote the stability of channels, banks, and side slopes, also help to protect fish and their habitat.

In addition to water quality measures, other protection needs within the riparian ecosystem are required for the fish resource:

1. An adequate supply of large organic debris is necessary for maintaining habitat and stream stability. Both short- and long-term supplies of large organic debris should be considered in the prescriptions of riparian management zones.

2. Considerations for the protection of understory vegetation are important. Vegetation within the riparian ecosystem is a principal source of food for the aquatic habitat. It supplies habitat for terrestrial insects which make up part of the fish diet. This vegetation also provides organic material for about 50 percent of a stream's food energy.

3. Protection of all the water bodies within the riparian ecosystem is important. Riverine ponds and headwall streams provide critical winter habitat for fish.

Protection needs of prime importance are large organic debris supplies, stream bank stability and water temperature.

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Wildlife Resource

To evaluate the protection needs for the game and non-game animal resource, the site specific habitat elements of the riparian ecosystem and their associated communities must be identified and analyzed.

Habitat Elements

Aquatic Element. Many aquatic mammals (beaver, river otter, muskrat, mink), some birds (waterfowl, shore birds, water ouzel, king fisher) and fish (trout, salmon) are dependent on the riparian ecosystem's aquatic element.

Riparian Element. The moist land immediately adjacent to bodies of water, is characterized by a variety of plant communities (edges), which support many species of wildlife. This area is also characterized by favorable thermal conditions for fish and wildlife, particularly during times of climatic stress. The riparian element is a highly preferred winter habitat for deer and elk, and also contributes nutrients to the aquatic system, including invertebrates upon which fish and amphibians feed.

Influence Area. The influence area adjacent to the riparian element is important to many wildlife species which use or depend upon the aquatic and riparian environment. For example, the bald eagle, osprey and great blue heron commonly nest in this area and big game species (elk, deer, black bear, cougar) use it for resting, feeding, thermal regulation, concealment and dispersal.

Cover-type Combinations

Hardwood Communities (riparian ecosystem: riparian element). This plant community is usually dominated by hardwood trees (alder, vine maple, big-leaf maple, cottonwood, willow, black ash, Garry oak) or mixed hardwood-conifer trees (Douglas-fir, sitka spruce, western hemlock, western red cedar). These hardwood stands are considered important habitat for many species of wildlife. Many of the song birds, plus the ruffed grouse (game bird), are dependent on hardwoods for nesting and/or feeding activities. Deciduous trees produce large quantities of wildlife food in the form of seeds (birds, small mammals), fruits (birds, mammals), stems (rabbits, mountain beaver), foliage (deer, elk), nuts (tree squirrels), buds (grouse, tree squirrels), and bark (beaver, small rodents). Beaver commonly use large hardwood stems for constructing dams and lodges.

Young-Mature Conifer Communities (riparian ecosystem: riparian element-influence area). Intermediate-age conifer stands are an important habitat for many species of wildlife. They are particularly important for providing concealment, dispersal, migration, thermal and denning requirements of big game species such as elk, deer, black bear

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and cougar. Many of the hawk and owl species, including the great blue heron, nest in this habitat. Young (<50 years) conifer stands are considered optimum concealment and resting habitat for deer and elk. Mature (>50 years) conifer stands in lower elevation riparian ecosystems are important winter ranges for deer and elk because they provide the best combination of forage, thermal regulatory, concealment and snow depth conditions.

Shrub Communities (riparian ecosystem: riparian element-influence area). These communities (salmonberry, huckleberry, willow, salal, hazelnut, oceanspray) are one of the most important wildlife habitats and the riparian ecosystem is one of the few forest areas where shrub communities can persist over long periods of time. Shrubs are also the primary source of fruit in forests. Many of the song birds nest in shrubs and feed on fruit. Many of the mammals use shrubs for concealment or resting and also feed on the foliage, fruits or stems; some even feed on bark and roots.

Natural Openings and Clearcuts (riparian ecosystem: riparian element-influence area). These areas, which are characterized by permanent or successional forb/grass communities, including some shrubs (usually), are essential or preferred habitats for certain species of wildlife (vole, pocket gopher, chipmunk, deer mouse, ground squirrels, song sparrow, white-crowned sparrow). They are also important or essential foraging sites for many species of wildlife (deer, elk, black bear, coyote, bobcat, raptors, song birds).

Natural or Artificial Wetlands--Marshes, Swamps, Bogs, Ponds, Seeps (riparian ecosystem: riparian element-influence area). The hydrophytic plant communities (cattail, sedges, rushes, skunk cabbage, willow) in wetlands provide feeding, resting, and nesting habitat for waterfowl, shore birds and wading birds. They are also important foraging areas for raptors. Seepage areas are preferred foraging and resting sites for elk, particularly during hot summer months.

Beaver Ponds (riparian ecosystem: aquatic-riparian element). Ponds created by beaver dams are usually found on smaller, low-gradient streams and provide highly preferred habitat for many species of wildlife (river otter, muskrat, otter, mink, racoon, waterfowl, shore birds, song birds), including amphibians and fish.

Old Growth Conifer or Hardwood Communities (riparian ecosystem: riparian element-influence area). Old growth forests are considered preferred habitat for a significant number of wildlife species and are essential or highly preferred habitat for some of the more specialized species (spotted owl, pileated woodpecker, marten). The bald eagle and osprey tend to prefer large old growth trees and stands for nesting, perching and roosting sites. These stands also provide favorable summer and winter thermal conditions for deer and elk and generally produce more big game forage than younger timber stands because of their more open crown cover.

Snags, Decadent Trees, Deadwood (riparian ecosystem: riparian element-influence area). These structures are important for reproduction, perching, roosting, feeding, resting, or denning activities of many species of wildlife. Many species of birds and a considerable number

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of mammals, use natural cavities, or cavities made by primary excavator-woodpeckers for nesting, resting, or roosting purposes. Many small mammals, reptiles, amphibians and invertebrates are dependent on decayed stumps and logs for nesting, concealment, foraging and protection from climatic stresses. Black bears use stumps and logs extensively for denning and feeding (insects) purposes.

Corridors (riparian ecosystem: riparian-aquatic element-influence area.) The riparian ecosystem is considered extremely important for migration and dispersal corridor for fish and wildlife. Fish, amphibians, and some aquatic mammals are totally or highly dependent on the aquatic element as a corridor; many mammals are dependent on the riparian-influence area as a corridor. The effectiveness of these corridors, however, are dependent on providing favorable habitat conditions for movement. Debris dams on streams and rivers, and timber harvesting or installation of roads, campsites or trails within the riparian ecosystem can destroy or reduce the value of the ecosystem's animal corridor function.

Buffer Zones (riparian ecosystem: riparian element-influence area.) Game animals and special interest wildlife occurring frequently or permanently near heavily used roads, trails, camp grounds and bodies of water (streams, ponds, lakes, rivers) should be protected from human harassment, illegal hunting or shooting, or road hunting by a substantial buffer zone of trees or shrubs. Buffer zones are important consideration for protecting raptor nesting, perching and roosting sites, particularly for the bald eagle, osprey and great blue heron.

Habitat Variation (riparian ecosystem: aquatic-riparian element-influence area). Habitat variation (differences in type, quality or size of habitat) is a natural or man-caused phenomenon which results in variation in the number and species of animals present between different segments of individual riparian ecosystems and between separate riparian ecosystems. This feature makes it difficult or impossible to manage riparian ecosystems for fish and wildlife in a simple manner.

Habitat Diversity (riparian ecosystem: aquatic-riparian element-influence area). The ability to maintain viable numbers of all animal species adaptable to riparian ecosystems depends upon an effort to maintain a high quality aquatic environment and a high degree of diversity of plant community types and succession stages in close proximity--in and adjacent to the ecosystem.

With the above wildlife habitat elements in mind, an assessment of needs can be made for a site-specific RMZ (reference: Wildlife Habitat Considerations in Forest Operations, July, 1983, Oregon State Department of Forestry and Oregon State Department of Fish and Wildlife). For the present there is little specific information available to help in operationally prescribing for these needs; however, the organization and incorporation of some general information

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into the decision making process for a RMZ prescription is an important first step in the right direction. Consultations may be helpful using department biologists and/or the Game Department. In the way of summary the important wildlife points are:

1. forage (feeding, nutrients, winter feed, insects, water).
2. hiding cover (escape, travel corridors, sight distance, concealment, migration, dispersal).
3. thermal cover (thermal regulation, winter range, summer range).
4. beds, dens, nests, perches, roosts (resting, reproduction, hunting).
5. diversity.
6. habitat variation.

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APPENDIX B

Appendix B: Riparian Management Zone Location and Harvest Considerations

Riparian ecosystems are among the most productive, sensitive, diverse, and often geographically limited ecosystems within our State forests. They have been recognized under a variety of names, such as streamside management units, valley bottomlands, water system corridors, and water influence zones.

The Department riparian management zone (RMZ) is found within the riparian ecosystem. To operationally manage this zone, there must be a system for field location of its width. As interim guidelines, the following are general rules of thumb which may be used individually or in combination. All are not used in every case.

A. Width

The minimum RMZ width shall be the legal requirement of the Forest Practices Rules and Regulations. Since nature rarely conforms to fixed standards, wider variable widths may be necessary to more precisely locate the RMZ boundary. One method is thru plant identification, thereby locating the approximate line of plant community change from wet to dry environment.

1. Plant Identification - The ability to recognize the specific plant communities is important to planning for land use practices. Certain communities are more prone to damage than others. Some communities also play a very important role providing for habitat and water quality protection.

   Certain plant species are considered indicators of specific environmental conditions. These indicators give clues to whether a plot or timber sale is located in a riparian, floodplain, or upland site community. Ecologist's have identified these indicator species and various communities based upon them (See figures 1 and 2).

   For example, a recent study grouped plants into separate moisture classes for Western Washington. They are as follows:

Very Dry:	Salal, *Gaultheria shallon* Hazel, *Corylus spp.* Oregon Grape, *Berberis nervosa* Ocean Spray, *Holodiscus discolor*
Modal:	Vanilla leaf, *Achlys triphylla* Dogwood, *Cornus spp.* Swordfern, *Polystichum munitum* Rhododendron, *Rhododendron spp.* Brackenfern, *Pteridium aquilinum* Vine Maple, *Acer circinatum*

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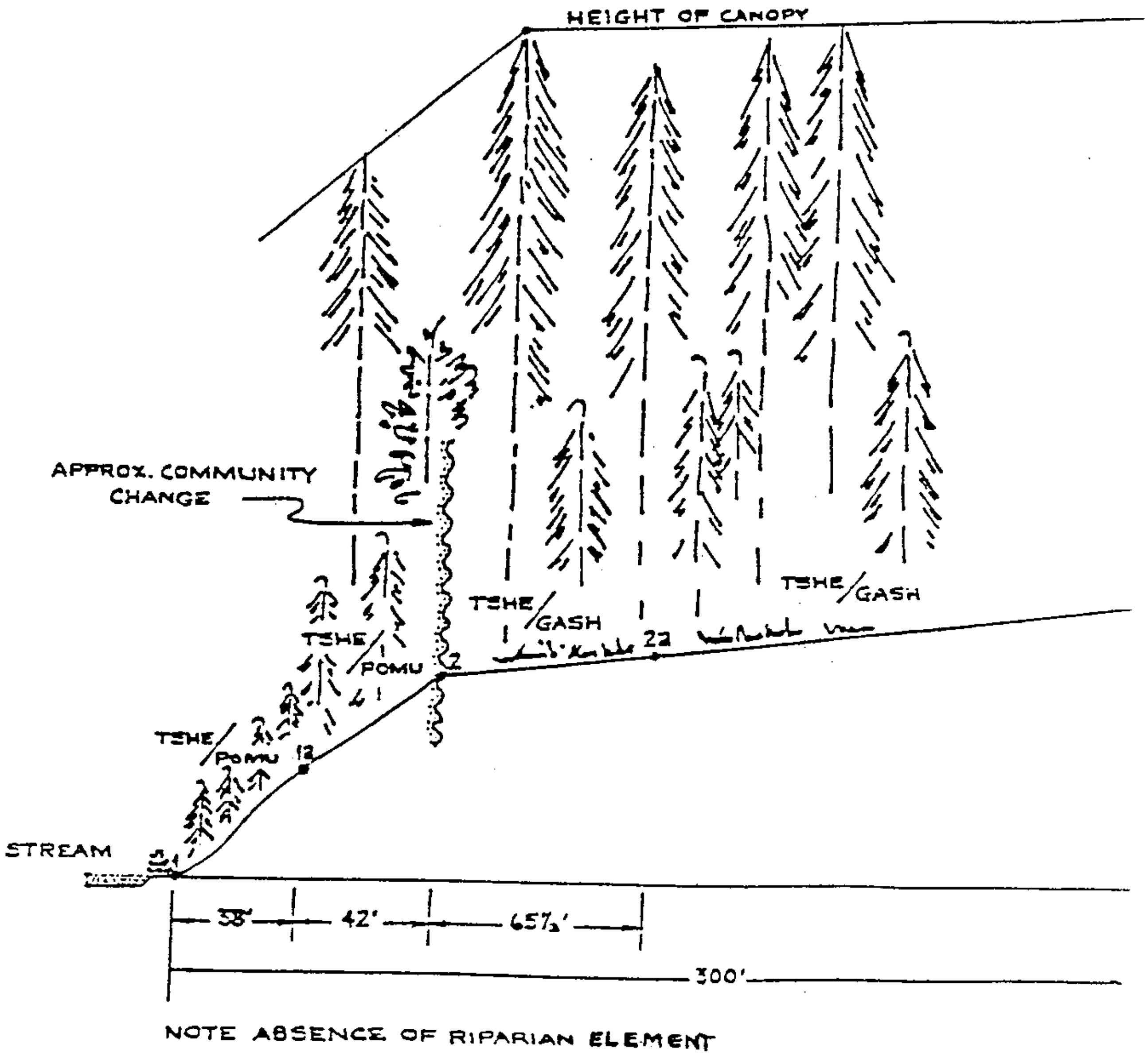

TSHE/POMU - *Tsuga heterophylla/Polystichum munitum* - western hemlock/swordfern
TSHE/GASH - *Tsuga heterophylla/Gaultheria shallon* - western hemlock/salal

Figure 1- Type Three stream on the Shelton Ranger District showing its associated plant communities.

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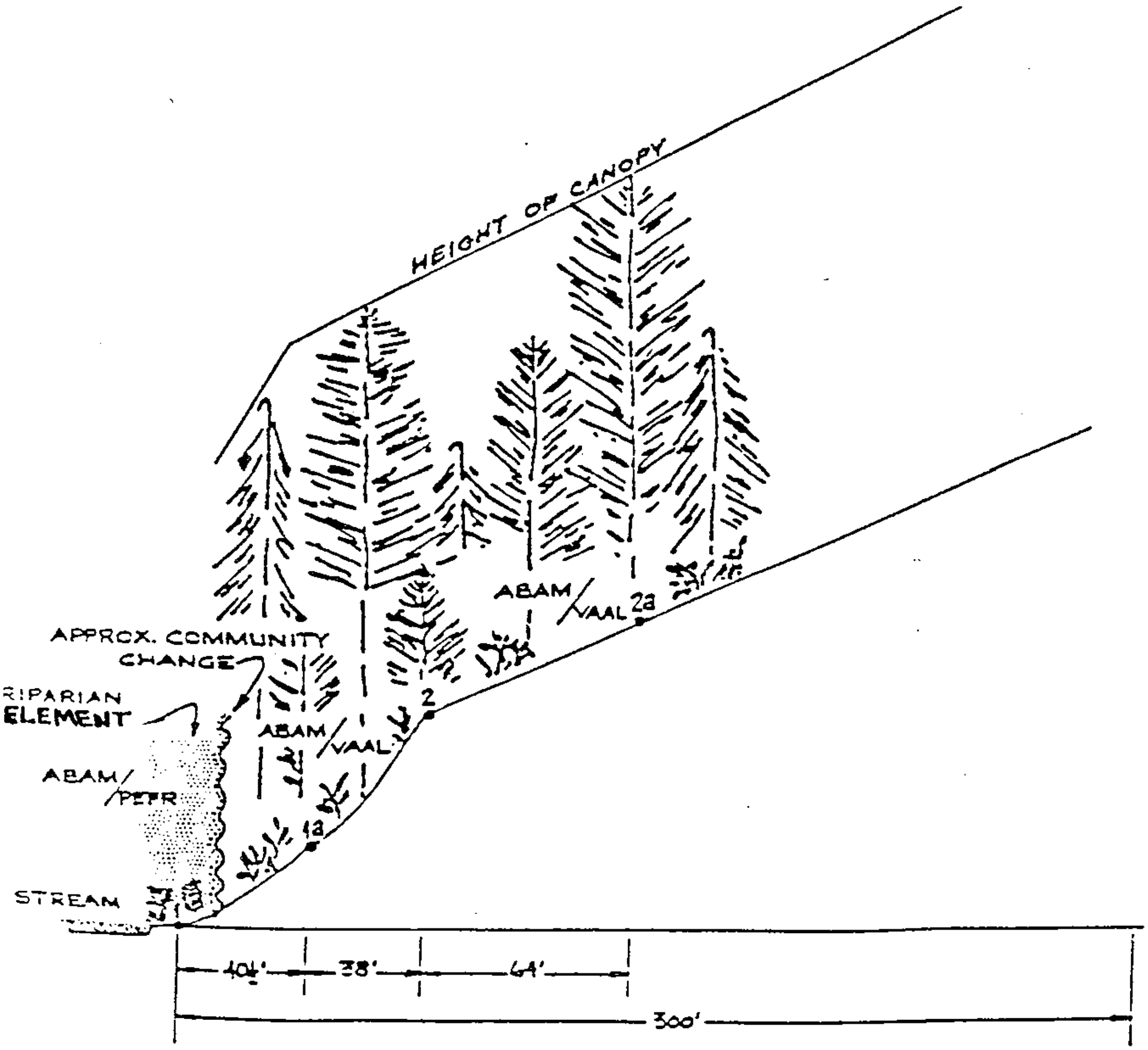

ABAM/PEFR - *Abies amabilis/Petasites frigidus* - Pacific silver fir/coltsfoot
ABAM/VAAL - *Abies amabilis/Vaccinium alaskaense* - Pacific silver fir/Alaska huckleberry

Figure 2 - Type Two stream on the Quinault Ranger District showing its associated plant communities.

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Wet:	Red alder, *Alnus rubra* Coltsfoot, *Petasites frigidus* Ladyfern, *Athryium filix-femina* var. *californicum* Oxalis, *Oxalis oregana* Red huckleberry, *Vaccinium parvifolium*
Very Wet:	Skunk cabbage, *Lysichitum americanum* Sedges, *Carex* spp. Devil's Club, *Oplopanax horridus* Salmonberry, *Rubus spectabilis*

In general, plant communities change along a transect up the slope from the waterbody. Information on the stocking levels required for significance is not now available statewide. The forester should be alert to noticeable changes in plant community types indicating moist soil conditions. RMZ boundaries should be located at the approximate change from a wet community to a modal one. Contact our forest ecologist for indicator plant lists of your area.

2. Water Influence Zone Calculation[1] - A method for determining the maximum width of the RMZ has been developed using the water influence zone concept. It is a method of identifying the area along a stream which can directly influence the aquatic ecosystem by contributing organic material and shading.

   The water influence zone (WIZ) is defined as the area comprised of the aquatic, riparian, and adjacent land ecosystems including flood plains and wetlands. Adjacent land areas along a stream are those that can directly influence the aquatic ecosystem by contributing organic material or shading. The floodplain on older meander type streams, with overflow areas, can make the water influence zone quite wide.

   The relationship of the components mentioned above is shown in figures 3 and 4 and assumes a mature or old growth stand condition. The point where the height of the tallest inventoried tree, located on the average slope for the site, intersects with the sun's angle of influence is the maximum distance where the two direct influences of the vegetation affect the stream. These are litter-twig fall and tree-top shade. A tree falling into the stream is another potential influence. On slopes under approximately 80% (38.5°) the tree height influence tends to be greater than the combination of litter-twig and tree-top shade. Due to this fact, horizontal distances from the stream as a pure function of tree height overrides the horizontal distance as a result of twig fall and tree-top shade.

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[1]Brown, Bill et. al. 1980. Riparian Vegetation, Streambank Stability Inventory. USDA Forest Service - Olympic National Forest. 24 p.

Figure 3 - New Stream Profile

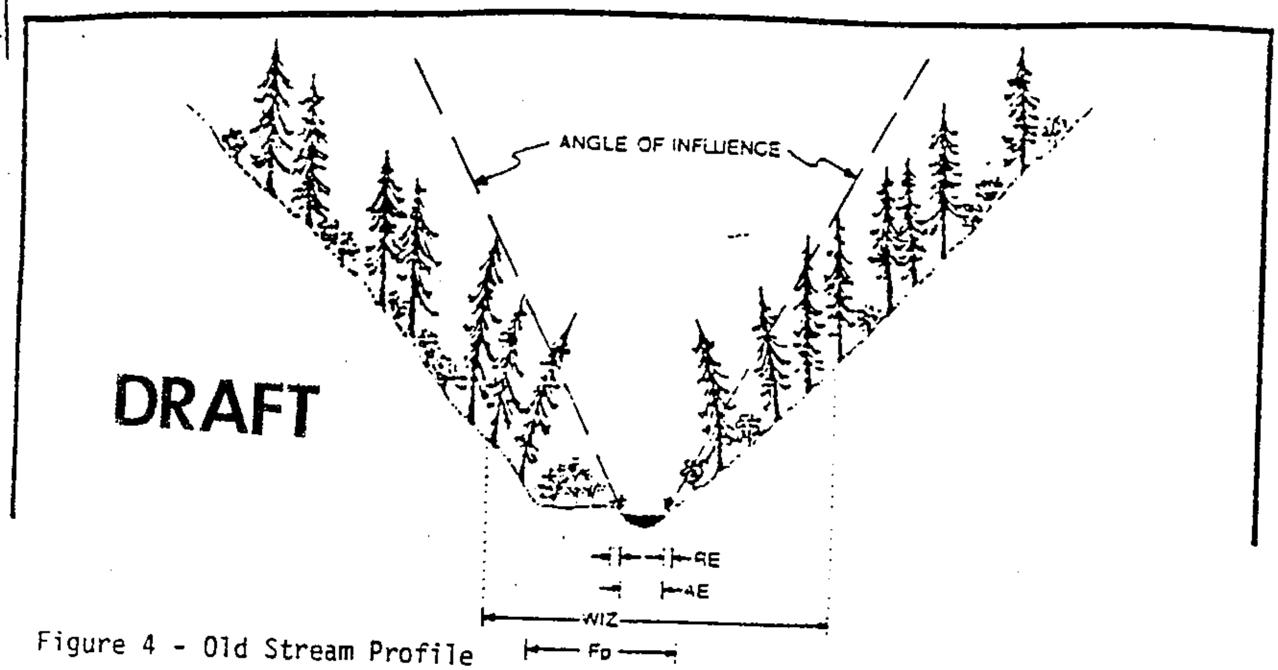
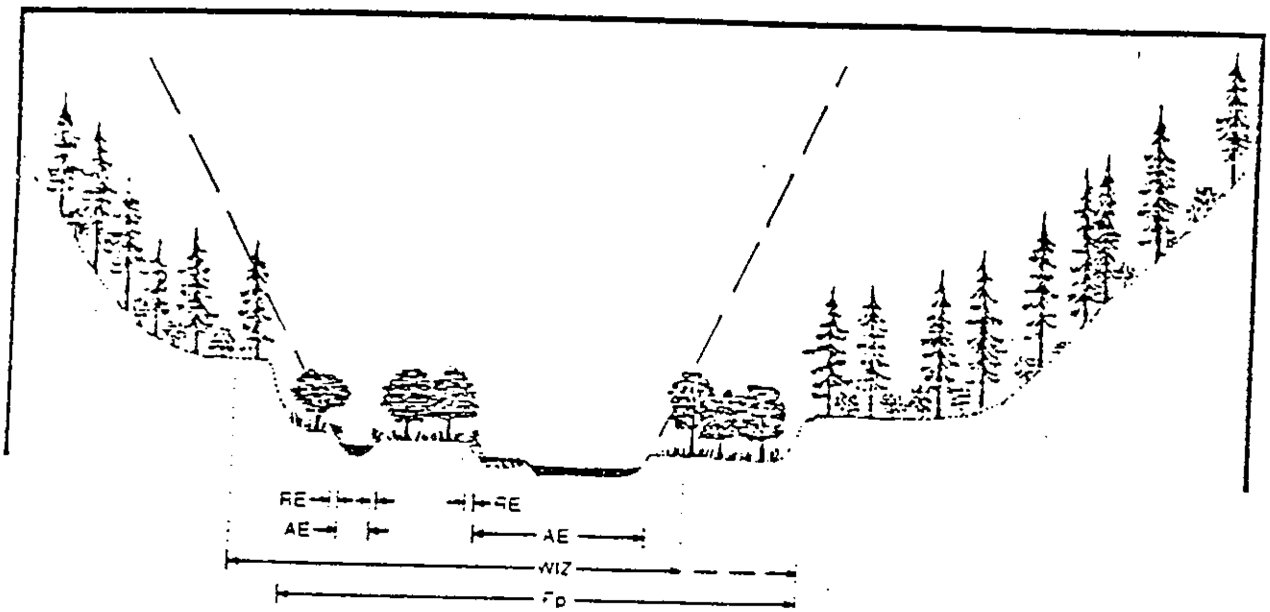


Figure 4 - Old Stream Profile



RE - Riparian element
AE - Aquatic element
WIZ - Water Influence Zone
Fp - Floodplain

Diagram of water influence zone showing the relationship between the aquatic element, riparian element, floodplain and adjacent land area.

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A correlation between the height of trees and the width of the WIZ has been noted. This was used to set up a table relating tree height to the width of the WIZ. It shows that as the height of the trees surrounding a stream increase so does the water influence zone. Knowledge of this relationship can be useful in field calculations for the WIZ. Knowing maximum tree heights in a given area allows one to calculate a maximum distance the WIZ could extend.

To determine the width of the WIZ, three factors must be taken into account. These are maximum tree height (old growth), sideslope, and the sun's maximum angle of influence (shading) during the summer. The first two factors are variable while the last is a constant (200%). The effective distance (width of the WIZ) is derived from a mathematical matrix (supplied) incorporating the three factors listed above. Width of the WIZ will change as the variables change (see figure 5 for matrix).

The water influence zone is important to a wide range of resources. It tends to be the area of highest timber production per acre. It provides food, cover, and water for wildlife. Snags play an important wildlife habitat role in this area. The water influence zone provides food as well as habitat for fish and protects water quality.

3. Topography - Another indicator which can be used to locate the RMZ boundary is topographic breaks. These breaks are created as a result of water influence on the landform (i.e., floodplains, stream terraces, (see figures 1 and 2). Topographic breaks influence the concentration of surface and subsurface water flow.

4. Presence of Surface Water - Look for moist soil conditions and evidence of seeps and springs.

5. Stability of Banks, Channels and Riparian Ecosystem (See Appendix A) - The width of the riparian management zone required for adequate water quality protection may be based on the stability ratings for banks and the riparian ecosystem. If the riparian ecosystem is rated unstable, then the width of the management zone should be extended to include the entire riparian ecosystem. If the bank is rated stable, but the riparian ecosystem is not, the management zone should include the flood plain. If the bank and riparian ecosystem are both rated as stable or if prescribed widths for the other conditions are less than the legally required width, then the legally required width is used. A minimum of 70 percent cover of deep rooted plant species should be maintained within the riparian management zone.

6. Filtering Affects for Protecting Water Quality (See Appendix A) - Effective filtering widths can be determined from the following guidelines:

Side Slope Gradient (percent)	Effective Horizontal Width (feet)
20 - 28	30
29 - 37	50
38 - 46	60
47 - 55	80
56 +	100

If overland flow is not likely to reach the riparian ecosystem, the required legal width should be used.

7. Thermal Quality Protection (See Appendix A) - Assessment of the needs for protecting thermal quality should begin by determining whether or not a water body is temperature sensitive using the criteria described in the Forest Practices Rules and Regulations. If it is not, then the required legal width is prescribed for the riparian management zone. The legal widths would also be prescribed for streams shaded by topography. When a stream requires shade from vegetation, the methods described in Part 2 of the Forest Practices Board Manual should be used to determine what vegetation must be retained. The width of the riparian management zone should be extended to include this vegetation with the minimum width being the legal requirement.

NOTE: The application of the above methods (legal requirement, plant identification, WIZ formula etc.,) requires integration, interpretation, and judgement by the local forester.

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FIGURE 5

TREE HEIGHT IN FEET

% SLOPE	100	150	200	250
130	143	215	285	355
100	100	150	200	250
70	82	123	164	205
35	95	142	189	236
0	100	150	200	250

Figure 5 - Maximum horizontal distance of the Water Influence Zone (measured from the line of vegetation next to the water)

Note: this is a composite of length of shadow at highest angle of summer sun and horizontal distance as a result of tree height.

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B. HARVEST CONSIDERATIONS

Harvesting. The degree of harvesting shall range from removal of all merchantable trees to no removal. When removing trees from RMZ cover types the following items must be considered:

1. Damage to the non-timber resource or habitat--To evaluate this concern, refer back to the objective for the zone and the needs or standards for meeting the objective, e.g., if the objective were for game animals and hiding or escape cover is a key need requiring sufficient plant density and diversity to hide 90 percent of a large animal from view for a sight distance from the nearest road, landing or first unobstructed view of the RMZ, then the degree of damage is determined by the amount of cover reduction below this need or standard for which there is an inability to re-establish within five years.

2. Economics or cost effectiveness of tree removal--This can be determined on a marginal basis considering the additional costs, e.g., pulling and jacking trees, extra roads and landings, special yarding requirements, grazing controls, layout and compliance costs.

3. Steepnes of slopes on either side of the waterbody.

4. Special felling techniques, e.g., directional felling, lining, jacking, stage felling.

5. Special yarding techniques, e.g., advanced yarding systems, full or partial suspension, no skidder yarding within the zone except in special cases, debris removal.

6. Road and landing location will affect future blown down salvage.

7. Minimize unnecessary damage to leave trees, understory vegetation and soil.

8. Consider forage and erosion seeding.

9. A graduated removal scheme of none or least next to the waterbody increasing to maximum at the outside perimeter of the RMZ.

10. Protection from fire, e.g., fire line pull back, logging and disposing of slash on one side of the RMZ at a time, no burning, low intensity burns.

11. Mark the individual "take" trees during presales.

12. RMZ's should be managed separately from the uplands, however, up slope management activities on very unstable slopes must be carefully designed so as not to destroy or negatively impact the RMZ's. There shall be no buffer zones or buffering practices between the outer boundaries of the RMZ's and the bordering timber lands.

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Leave Trees. When planning and laying out riparian zones, the leave vegetation should be as follows:

1. Hardwoods.

2. Existing snags (consider safety concerns).

3. Raptor nest trees, perch and roost trees.

4. Low value wolf and decayed trees.

5. Heavy leaners which cannot be directionally felled away from the water and the zone.

6. Greatest number of stems will be in the small diameter classes with the number decreasing as size increases until the largest trees are few and well scattered.

7. Trees in close proximity to the water and display large root systems that are partially visible and appear to be offering significant bank stability (generally are also very wind firm).

8. Down trees keyed into banks and other detritus (large dead woody debris).

9. Leave high stumps within the zone as hillside trash racks and nongame habitat.

10. Nonmerchantable conifers.

11. Future stands in the RMZ should be uneven aged with a mixture of tree species and heights.

Wind Throw Potential. The evaluation of the RMZ for wind throw potential is important as all our concern and effort can be for naught. Old windfalls and pit and mound topography can be assessed for the direction of damaging winds and potential for future windthrow. General stand condition and overstory species composition, e.g., western hemlock, can be used to assess windthrow susceptibility. Other indicators such as stream bank cutting, large debris jams, swampy areas and landslide scars also indicate natural instability. Trees with stem rot may be susceptable to windbreak. Open grow trees are more wind firm than those which were supported by a dense stand. Short stocky trees have a form point that gives them good stability and windswept trees have an inherent stability. Fire weather expertise can provide information on the modification of wind patterns by topography.

Cover-type Prescriptions. The following examples of cover-type prescriptions were primarily developed by the Ozette District in the Olympia Area:

1. All Alder RMZ.

   a. leave intact or develop manage strategy to create uneven-aged hardwood-conifer mix.

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2. Windthrow Potential. This cover-type includes the 1921 hemlock blowdown and others identified as being highly susceptible to blowdown.

   a. leave the standard categories described in the "Leave Tree" section.

   b. log 75 percent of merchantable timber knowing the remaining trees have high potential to blowdown.

   c. reforest with shade/moisture tolerant tree species for an uneven-aged hardwood-conifer mix.

   d. keep in mind topographic wind shielding and modify accordingly.

3. Old Growth.

   a. leave the standard categories described in "Leave Tree" section.

   b. selectively cut by value and wind firmness; favor leaving windfirm old-growth sitka spruce, western red cedar, and Douglas-fir depending on the nontimber resource needs.

4. Hardwood-Conifer Mix.

   a. leave standard category described in the "Leave Trees" section.

   b. pick out high value trees for removal.

   c. preserve the species mix; strive for uneven aged condition.

5. Brush.

   a. leave intact.

ALTERNATIVE POSITION STATEMENT

by

Scott Berg

The Riparian Habitat Technical Report represents interpretations of selected research literature and the perspectives of professional biologists from the fisheries and wildlife subcommittees. The Forest Practices Board should be aware of alternative viewpoints that were discussed but do not appear in the report and research literature that indicates positive influences of Forest Practices in order to obtain a balanced and interdisciplinary perspective on this complex issue. I therefore respectfully submit several alternative position statements based upon my interpretations of the literature and personal inspection of over seventy-five certified Tree Farms in Washington State.

WILDLIFE CONCLUSIONS AND RECOMMENDATIONS

Riparian ecosystems are important wildlife habitats, primarily because of the presence of water and its influence on associated vegetation. The relative importance of riparian areas for wildlife tends to increase oas the availability of water in the overall environment decreases. Lush vegetation occurs uniformly throughout westside forests because of the high availability of water which is restricted to riparian areas in the drier forests of the east side of the State.

Major presettlement natural disturbance processes of wildfire, wind, and floods maintained varying stages of vegetative succession along streams with undisturbed old growth occurring primarily along major river valleys and floodplains (Hemstrom and Franklin, 1982; Brown et al. in press). At any given point in time varying successional stages along streams created a mosaic of vegetation types to which fish and wildlife have adapted over time. As succession progresses, conditions become more favorable for some species and less favorable for others. The greatest diversity of wildlife will consequently occur in riparian areas containing a variety of all successional stages.

Since the settlement period started on the west side about 1850, logging and clearing of major waterways for transportation has removed all but a few examples of old growth ecosystems. Secondary succession has replaced Type 1,2 and 3 riparian areas with hardwoods and some shade tolerant cedar and hemlock growing in the understory and Type 4 and 5 waters with alders and assorted conifers, depending upon the local climatic conditions.

Modern forest practices are restricted in riparian ecosystems by Forest Practices Regulation, the Hydraulics Code, the Shorelines Management Act, and individual landowner policies. These combined restrictions result in a wide range of vegetative conditions from maintaining hardwoods along some Type 1, 2 and 3 waters, old growth along some Type 1 waters classified as shorelines of statewide significance, and conifers along most Type 4 and 5 waters. INtensive forest management, in reality, is limited to upland Type 4 and 5 and some Type 3 waters. The effects on wildlife are to generally favor grass/forb through mature conifer successional stages and their dependent species along these small streams and hardwood dependent species along intermediate streams. Remnant old growth and associated species are present along some inaccessible streams. All successional stages and their dependent wildlife species are potentially provided on state and private forest land.

Where intensive forestry is practiced in the uplands, differences between natural and forest practice caused patterns are related primarily to the accelerated rate of succession caused by planting, vegetation control, and thinning along Type 4 and 5 waters and a shorter time frame between disturbance. While the above discussion represents general trends, the actual extent to which hardwoods, old growth, and young successional stages are provided has not been studied.

<u>Food and Cover:</u>

The current Forest Practices Act, Hydraulics Code, landowner policies, and Shorelines Management Act rules restrict short rotation intensive forest management in intermediate and large stream riparian ecosystems. Old growth forests were cut from along most major rivers in western Washington before the advent of the above legislation. Large trees that remain along shorelines of statewide significance are afforded protection under the Shorelines Management Act by limiting the harvest to 30% of the trees in any decade, and in most cases every rotation. Further protection is afforded to those species that are federally listed as threatened and endangered through the Class IV Special category. Current procedures are designed to preserve those critical habitats which will ensure that none of the threatened and endangered species will be lost.

Wildlife species dependent on hardwoods are at higher levels than at any other time in the past. Following initial logging of the old growth, may riparian ecosystems regenerated to pioneering hardwoods. In western Washington between 1933 and 1977, hardwood cover types on all commercial forest lands leaped from 237,000 acres (2%) to 1,978,000 acres (12%) (American Forest Institute, 1946; USFS, 1981-82). Given current forest practices rules that restrict the use of herbicides along Type 1, 2, 3 and some 4 waters, the current level of hardwoods will be maintained by continued harvesting. The only way to significantly reduce the number of hardwoods in riparian ecosystems would be to "protect the stand" and allow shade tolerant conifers to overtop and suppress the shorter lived hardwoods. Without an understanding of the ecological relationship of conifers succeeding hardwoods, perceived protection for hardwood dependent species would actually result in their overall reduction over time.

Recommendations:

Because short rotation forestry is not being practiced in all riparian ecosystems on all ownerships, it is unclear whether wildlife species composition is being "permanently changed" or "species eliminated". Major reserves of old growth riparian ecosystems and their dependent species are potentially provided on portions of the 4.5 million acres in parks and wilderness areas along with the 1.0 million acres of commercial old growth that will be withdrawn from harvest as part of the minimum wildlife management requirements of the U.S. Forest Service planning process. These ownerships should be included in the analysis to ensure an accurate representation of overall riparian habitat conditions in the State. I recommend that the following steps be taken to fill those information gaps during Phase II.

1. Monitor the USFS old growth research efforts to identify which wildlife species are in fact dependent on older forest successional stages.

2. Inventory a statistically sound sample of riparian ecosystems to identify the various successional stages that occur along different water types on state and private land.

3. Identify the amount of old growth and other successional stages along streams on adjacent ownerships and lands withdrawn from production.

4. Determine the potential for the permanent change or elimination of species in riparian ecosystems based on an overall analysis of successional stages occurring in riparian ecosystems and the Class IV Special protection afforded to threatened and endangered species.

5. If any one successional stage is at critically low levels that may lead to the elimination of species from the riparian ecosystem, identify a range of options to provide the necessary habitat.

Snags and Down Woody Material

Riparian ecosystems are currently managed extensively with restrictions mandated by the aforementioned environmental laws and the Department of Labor and Industries Safety Regulations. These result in SMZ's with varying amounts of snags and down woody material in old growth, hardwood, mature conifer, pole saping, shrubs, and grass/forb stages of succession. Due to the distance of SMZ's from landings and the low value of some species and decadent timber, snags and down woody material are usually left in place and not yarded.

Although there is an overall trend toward fewer snags and down woody material in the uplands, their relative abundance in riparian ecosystems is unclear because no statistical sampling has been done. I know of no evidence that suggest a permanent reduction leading to the "elimination" of any species as a result of current riparian ecosystem management. If a species were to become federally threatened in the future, the Class IV Special designation is designed to prevent the further loss of essential habitat.

Recommendations

The Phase II investigation should conduct a statistically sound sample of a variety of riparian ecosystems to determine the current extent of snags and down woody material. If the survey indicates that this habitat is at critically low levels, proceed to the following recommendations.

1. The Department of Game should continue to work with the Department of Labor and Industries to resolve current safety related conflicts.

2. Several other resource management conflicts work against the retention of snags and down logs. Fire protection laws and concerns for smoke management currently pressure resource managers to remove any unmerchantable material that may potentially spread fire or smolder for days. These conflicts must be resolved with other regulatory agencies and forest managers before any decision can be made to retain additional snags and down log habitat.

3. Once safety, fire hazard, and smoke management conflicts are resolved; the Department of Game should recommend guidelines for a number of snags and down woody material that will retain sufficient habitat for reasonable numbers of dependent species.

Disturbance and Harrassment:

Conclusions

Initial railroad development followed rivers and streams due to the need for a more gradual slope gradient. Old railroad right-of-ways have been in place for some time and many have been converted to haul roads. State Forest Practices regulations and the Hydraulics Code regulate new road construction, design, drainage, bridge and culvert installation, disposal of excavation material and compaction. The Forest Practices regulations governing road location require minimizing roads in and adjacent to streams and wetlands, minimizing stream crossings and, whenever practical, crossing streams at right angles. No analysis has been made of roads situated within forest riparian ecosystems or the rate at which new roads are being constructed or reconstructed. Many foresters believe that the majority of large access roads are already in place.

Recommendations

The Department of Game should identify those roads, seasonal use patterns, and types of use such as recreation that are creating disturbance and harrassment problems for riparian dependent wildlife. They should then pursue a voluntary road management agreement with individual landowners to limit the use of those roads during critical times of the year. A framework already exists for establishing such road closure agreements and the program has been successful.

Fisheries Conclusions and Recommendations:

Fish species have evolved under and are adapted to varying environmental conditions. Natural disturbance processes such as wildfire, floods, windthrow and insect and disease have periodically and continuously modified riparian ecosystems. Based on the historical record, Hemstrom and Franklin (1982) found that 90% of existing stands in Mt. Rainier National Park developed after fire and are in varying stages of succession with only the valley bottoms, alluvial terraces and protected north facing slopes occupied by old growth stand structure. The historical record also indicates that rivers with old growth timber had large numbers of fallen trees in their mainstream and side channels (Sedell and Luchessa, 1980). Settlement over the past 150 years has dramatically altered both riparian ecosystems and fish populations through the influence of impoundments, agriculture, urbanization, channel clearing and channelization, forestry, and over fishing.

Forest practices have continually evolved and improved over recent years with changes in knowledge and attitudes, improvement in working relationships between biologist and foresters, and regulatory programs. As a result of some of these changes, the 1980 Forest Practices Assessment of the adequacy of Washington's forest practices rules and regulations in protecting water quality reported that when the forest practices rules were complied with, no water quality impacts were noted in 99.6% of the cases. This included an analysis of road construction and maintenance, clearcutting, site preparation, and streamside management. The SMZ analysis found that overall, operators were meeting the requirement to "avoid disturbance of brush and similar understory vegetation", maintain streambed integrity, and protect water temperature.

The most recent rule changes of October 1982 further improve upon Best Management Practices designed to provide adequate protection to fish and fish habitat. Even in intensively logged watershed such as the Clearwater River on the Olympic Peninsula, researchers have stated that "logging impacts tend to be subtle". Often they appear visually worse than they actually are in terms of their impact on the fisheries resource (Cederholm and Martin, 1983).

Stream Channel Shape and Structure:

Research in the recent past has questioned the old policy of stream cleanout and log jam removal. It appears that organic debris in streams occurred naturally and served the function of structuring fish habitat with alternating riffles and pools. Continuing to remove organic debris from the streams and the loss of potential suitable replacements from riparian ecosystems can result in the long term modification of fresh water habitat.

The concept of woody debris management rather than removal is relatively new. Insufficient knowledge and the complexity of the issue has resulted in conflicting management policy and direction to both field foresters and fisheries biologist. Some of the questions that remain to be answered or clarified include: how much debris is optimum, what size debris is appropriate for each water type, what are the legal implications to landowners of aggravated storm damage caused by organic debris, what are the effects on recreational boaters, what are the relative economics of organic debris for the fisheries and forest products industry, what constitutes a barrier to fish migration, and many others. Woody debris management is an overall resource management problem that involves the influence on fish habitat as but one of many issues that must be considered.

Recommendations:

The Phase II investigation should attempt to address as many of the relevant unknowns as appropriate. Additional research needs should be identified to fill information gaps. Expertise necessary to address the issue will involve the cooperation of fisheries biologist, a hydrologist, an economist, input from legal authorities, and foresters familiar with geology, soils, and windthrow potential.

Mass Soil Movement:

While the effects of mass oil movement on fish habitat are generally considered to be negative; landslide caused sedimentation, deposition of organic debris in streams, and scouring of stream substrates occur naturally and with varying frequencies during the life span of aquatic organisms (Cederhold et al., 1981). Clearcutting may alter the timing of debris avalanche erosion, but it may not necessarily increase the overall rate on the time scale of one or more timber rotations (Swanson et al, undated). Short term positive effects of mass soil movement have been observed in several cases including the deposition of spawning gravels in coastal streams where over 130 splash dams removed natural gravels (Geppert et al., 1983). Also, in a study conducted in the Oregon Coast range, the overall effect of mass soil movement was positive. Debris torrent ponds were rearing coho at a rate nearly 10 times greater than the unponded habitat (Everest and Mehan, 1981). Based on a full review of the literature, it appears that mass soil movement must be analyzed in the long term with an open mind to both positive as well as negative effects.

Research has shown that past road construction rather than clearcutting is the main cause of mass soil movement. The October 1982 rule changes contained several provision for reducing the potential for mass slope failures, including a Class IV Special review for roads on unstable slopes. It is clear from the limited amount of information obtained to date whether those rule changes are effective in reducing accelerated mass soil movement from roads.

Recommendations:

The DNR should continue to keep accurate records on the Class IV Special review of roads on unstable slopes until such time as a clearer picture becomes available. The DNR staff should then prepare a report to the Board regarding the relative effectiveness of those 1982 rule changes.

Water Quality:

Increases in light and water temperature have recently been shown to be beneficial to fisheries production in some regions of the State (Murphy e al., 1981; Cederholm et al., 1981). The forest practices rules were developed before this information becomes available and do not recognize the advantages to fish production of opening the forest canopy. It is conceivable that allowing sunlight to increase primary productivity and raise water temperatures could be an enhancement technique on a site-specific basis.

Recommendations:

Identify where and under what conditions increases in light and water temperature are beneficial to fish production. Develop methods to increase fish production by opening the forest canopy on a regional basis while ensuring stream bank stability.

Suspended Sediment:

An assessment to the adequacy of Washington's Forest Practices regulations in protecting water quality was conducted in August of 1980. Impacts to waters most important to fish use were judged to be relatively low overall. However, sediment from roads was identified as a concern and a recommendation was made to develop a forest roads manual to reduce sedimentation. A Forest Roads Handbook was subsequently developed as an educational tool. It is unclear whether this educational tool is being used to its full potential.

Recommendations:

A variety of methods and options are available in a slide-tape program and handbook designed as an education al tool to minimize sedimentation from forest roads. The Department of Natural Resources should develop several education strategies that will result in the greater application of Best Management Practices contained in the handbook on a site specific basis.

Supplemental Recommendations:

Current wildlife and fisheries management direction to foresters is presented as mandatory permits, regulatory procedures, compliance requirements, and fines. These negative incentives foster adversarial relationships that constrain effective communication and cooperation. Professional management of the forest, fisheries, and wildlife resources could be enhanced by a system of positive incentives.

The Phase II investigation should develop a range of positive incentives including: joint meetings between professional resource managers, an environmental logger of the year award similar to the program in Oregon, other positive recognition schemes between the professions, greater reliance on education and training of those involved in day to day operations, tax incentives and compensation to landowners for providing public resource benefits, and others as appropriate. Recommendations should be presented to the Forest Practices Board, state agencies, forest landowners, and environmental organizations.

Chapters 1-4

Page 1. Forest Practices Directive No. 5

The purpose of the second phase of the Riparian Habitat Technical study was to evaluate the biological needs of fish and wildlife in light of legal, social, economic, and institutional considerations. The May 17, 1982 letter from Brian Boyle and Don Moos specifically mentioned that the cost effectiveness of management options was to be considered along with the biological management options. I believe that a thorough knowledge and understanding of these relationships is critical for the Board to fulfill the intent of the Forest Practices Act.

Page 5. Study Limitations

Several additional limitations of the report must be explicitly recognized and understood by the Forest Practices Board. The report represents interpretations of selected research literature that address forest practices conducted under different regulatory and environmental conditions than currently exist. The report therefore represents potential worst case impact that may not be occurring in Washington under more recent regulatory programs.

The limitation that the report does not represent current forest practices in compliance with the recent forest practices rule changes is exacerbated by not including other regulatory programs that restrict forest practices such as the Shorelines Management Act and Hydraulics Act. All regulations that affect forest practices should be included in order to accurately reflect how riparian habitat is affected by forest practices.

The further lack of on-the-ground field checks and inventories precludes accomplishing objective b. which is to describe <u>existing</u> conditions including the type and extent of changes in reparian habitats caused by forest practices. Due to the lack of statistical sampling, we have little objective information on which to base a determination of the extent of intensive short rotation forest management occurring in riparian ecosystems, whether snags and down woody material are at critically low levels, and the extent of new roads in riparian ecosystems, among others.

<u>Page 6. Riparian Ecosystem Concept and Baseline Condition</u>

The riparian ecosystem defined in a functional sense should include the zone of direct interaction between terrestrial and aquatic environments. This zone od direct influence as defined by Swanson et al. (5), incorporates a variable strip of vegetation "extending upward and outward from the stream through the <u>overhanging</u> canopy." On large Type 1 and 2 rivers this includes herbaceous ground cover, understory shrub vegetation, overstory trees on the floodplain, and possibly the upper parts of trees rooted at the base of adjacent hill slopes that "lean out over the streams."

The width and vegetative composition of riparian ecosystems depends upon the stream size, gradient, and light availability. Intermediate and small stream riparian ecosystems that are dominated by an overstory of trees may have little understory vegetation due to the lack of lateral light and are largely indistinquishable from adjacent upland vegetation. Wildlife interactions with these small Type 4 and 5 streams are more closely associated with the surrounding uplands than the larger stream riparian ecosystems described in the report.

A baseline condition of vegetation in riparian ecosystems should reflect natural presettlement conditions as reported in the scientific literature. An accurate knowledge of forest ecology including natural disturbance is fundamental to a realistic interpretation of the dynamics of the stand mosaics that make-up the landscape and is necessary to understanding the role of future disturbance, including the effect of forest practices (Hemstrom and Franklin, 1982).

Natural forest riparian ecosystems were periodically affected by wild fires, floods, wind storms, and insect and disease outbreaks creating a mosaic of successional stages and their associated wildlife species. True old growth forests, including the visualized condition used by the report, occurred along the major river valleys and some protected north facing slopes in the cascades (Hemstrom and Franklin, 1982) and in areas of high precipitation along the coast. Intermediate and small streams were periodically affected by natural fires, depending upon rainfall amounts, allowing pioneering shade intolerant species such as Alder and Douglas-fir to be established. Most small and intermediate streams with fire successional Douglas-fir burned at approximately 100-250 year intervals, thus not allowing old growth structure to develop (Franklin and Dyrness, 1973). Fire recurred every 5-20 years in the east side ponderosia pine/mixed conifer type (Wright, 1978)

A more accurate representation of a baseline condition should be riparian ecosystems composed of a mosaic of successional stages that are continuously changing and being modified by natural processes. The verification of these processes was the dominance of Douglas-fir along most Type 3,4 and 5 streams on the west side, a successional species that is maintained by fire or other major disturbance.

Page 10. Distinquishing Characteristics

The distinquishing characteristics of riparian ecosystems are provided by all successional stages, including the visualized old growth baseline. For example, the pole/sapling stage includes the presence of water, more complex vegetation, linear shape, various edges, microclimate differences, and recurring disturbance. Each successional stage is also distinquishable from the others as to the degree of edge and microclimate and supports its own unique array of associated species. The distinquishing characteristics of riparian ecosystems are, therefore, not confined to any one successional state or plant community (Brown et al., (22).

Page 21. Wildlife Requirements

Brown et al., (22) reports that "natural succession following major disturbances such as floods, fires, or logging, often determines the kinds of vegetation occurring in a riparian zone at any given time." Food and water, areas to breed and year round, areas to hide and rest, areas to escape weather, and areas for travel are provided in varying degrees and for different species depending upon the successional stage that may be present. The report's assertion that a single visualized old growth baseline "provides more habitat niches for wildlife to meet their life's needs than any other type of habitat", is out of context with the supporting literature of Brown et al., (22). I believe, as I interpret Brown et al., (22) to intend, that riparian ecosystems with representatives of each successional stage provide more habitat niches for wildlife than any one successional stage. This should be evident from Table 12 which shows the various wildlife species associated with each successional stage, some of which are limited to only one or two successional stages.

Page 29. Wildlife Species listed in First Category

For several species in the first category of wildlife which "require riparian ecosystems to satisfy a vital habitat need," loss of the grass-forb and shrub-seedling successional stages may result in their overall reduction. For example, the Red-winged Blackbird is one of forty species that has an obligate relationship with these two early successional stages. Three of the forty species are primarily associated with riparian areas (Lang, 1980). Management of riparian ecosystems in old growth or any other successional stage other than the grass-forb/ shrub-seedling stages could dramatically reduce those species in riparian ecosystems.

One assumption of the report is that forest practices are conducted in compliance with the Forest Practices Act. The bald eagle and other Federally listed threatened and endangered species are afforded Class IV special protection under the act. Current regulatory procedures require landowners to leave an undisturbed seven acre primary zone around the nest with an additional twenty-four acres in a managed secondary zone where activities are conducted outside of the breeding season.

Page 37. Residual Effects

Residual effects and streamside vegetation recovery are critical factors that must be considered in order to better understand how fish habitat components are actually affected by forest practices over time. Again, consider woody debris in a Type 3 or smaller stream. If a stream is cut to the edge, residual organic debris may continue to function until it decays: from twenty-five to one-hundred years (Swanson et al., 1976). Given that a mature stand of timber will be regenerated on that site in approximately a 50 years rotation and woody debris enters through blowdown or placement at the end of the rotation no loss of woody debris function would occur (Dr. Bill Royce, personnel communication).

Page 61. Fertilization and Herbicide Use

Fertilization and herbicide use is restricted within riparian ecosystems, depending upon size, due to forest practices regulations. Because of buffer strip restrictions and the competitive advantage of hardwoods over conifers in high moisture areas, pure confierous stands very rarely occur.

Based on my personal experience, Type 1 and 2, most 3's and some 4's are generally not managed under intensive short rotation regimes. Type 1 waters managed under Shoreline Management Act (shorelines of statewide significance restrictions) typically contain some large conifers. Type 2 and 3 waters generally have hardwoods and some unmerchantable conifers left, and some Type 4 waters some back in hardwoods.

Page 63. Wildlife Species Dependent Upon Deciduous Trees

Deciduous trees are present along major rivers subject to periodic flooding where exposed soil is reinvaded by these pioneering species. Deciduous trees are also present along intermediate and small streams where timber harvesting or natural fire has removed the overstory and allowed them to become established. Since most deciduous trees are successional along these streams, "protecting" them will permit conifers to overtop and replace them. Beaver, sharp shinned hawks, downy woodpeckers, and robins are actually benefited by timber harvesting which factors hardwood establishment along these streams in the long term.

Page 71. Woody Debris

It is not correct to class all natural debris desirable and all logging debris as undesirable (Hall and Baker, 1975). For example, all indications may be that the debris in a particular channel is not seriously affecting fish production and that removal operations would likely do more harm than good. While the intent may be to leave intact any natural debris often proves difficult. The result of the cleaning operation is often a channel almost completely devoid of debris (Hall and Baker, 1975)

Page 76. Mass Soil Movement

Mass soil movement associated with timber harvesting may be triggered by intense rainfall events and requires a steep slope to initiate movement and to keep it moving. Soil movement usually stops when the gradient moderates (2-5%). Mass soil movement is most common on 1st and 2nd order streams, rare on 3rd and 4th order, and very rare on larger streams (Geppert et al., 1982).

These steep gradient 1st and 2nd order streams over 5-10% slope typically have very few if any spawning and rearing salmon (Royce, personal communication). A "significant long term loss of fish production" and "severe habitat degradation" in these steep gradient streams is not likely to occur is not supported by the research literature.

In May 1971, two massive landslides were caused by logging road failures in the steep upper Stequaleho Creek Basin. Four additional natural slides also added a considerable amount of sediment. Cederholm et al., (1978) concluded that the influence on total coho salmon habitat was probably minor due to their use of tributaries for spawning and rearing. There was no significant difference in benthos abundance above and below the mouth of Stequaleho Creek for the next three summers and no difference in the trout (cutthroat and steelhead) or total teleost mean biomasses for any of these years. It appears that the debris torrent landslides have had a significant but short-term influence on the spawning gravel composition of Stequaleho Creek. Within two years, sedimentation rates were essentially returned to normal.

Based on the relevant studies conducted in the northwest, roads have been shown to increase debris avalanche frequency and to have greater impacts than mass movement from harvesting alone (Swanson and Lienkaemper, 1978). It should be noted, however, that the research literature on both debris torrents and avalanches examined roads constructed prior to recent forest practices rules changes. Modern road building in compliance with the 1982 rule changes has not been evaluated and may not cause unacceptable increases in mass soil movement.

Page 77. Fine Sediment

Experimental watershed studies have not documented significant negative effects on fish or insects (Krammes and Burns, 1973) while the best documented effects have been positive. Murphy et al., (1981) show that changes in trophic status and increasing primary productivity resulting from shade removal may mask or override the effects of sedimentation. Also, Erman (1977) reported significant increases in numbers of aquatic insects in streams of logged areas, as compared with nearby control streams. Moring and Lantz (1975) report an increased biomass of coho salmon in the post-logging period in the Alsea Basin studies. Martin (1976) found that there was no significant difference between benthic fauna standing crop between logging affected and unaffected streams. Gammon (1970) found that bottom fauna populations recovered completely within a few days after suspended sediment concentrations were reduced.

Page 77. Sources of Sediment

In another example of 12 streams studied in southwestern Washington that were actively managed for commercial timber production, none contained sediment in amounts considered to impair salmonid survival (Duncan and Ward, unpublished). A significant positive correlation was obtained, however, between percent of watershed area in sedimentary rock and percent of medium and fine sand, silt and clay particles in spawning gravels. The amount of fine sediment (<2mm in size) was more closely correlated to lithology and soils on the watershed than forest management practices, specifically forest roads.

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Alternative Position Statement - Phase I
Forest Riparian Habitat Study

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The riparian habitat technical committee approached the Forest Practice Board's request to examine fish and wildlife use of riparian habitat, and how these uses are influenced by forest management activities, by bringing information available from the literature together with the experience and judgment of selected individuals technically trained in fisheries, wildlife and forest management. The study did not attempt to quantify riparian conditions currently existing in Washington State, and more importantly, did not consider current composition or levels of fish or wildlife populations. This lack of actual on-the-ground information, coupled with a published information base which reports a wide variety of responses by fish and wildlife to forestry-caused habitat change and the fact that committee members exercised their individual judgment as to both the significance and magnitude of these changes resulted in a lack of consensus in a number of instances. The purpose of this position statement is to identify some of the more significant of these points of contention and provide information to assist the Board in planning for future action.

An important point made in Chapter I dealt with the problem of inadequate information as described above, and states that to be objective, long-term field studies are necessary to identify cause and effect relationships. This was given as a reason for not conducting field studies, along with a lack of funding for such work. This lack of specific information on riparian wildlife, in particular, contributed much to the committee's inability to reach consensus in many instances. Many of the overall recommendations of the report further reflect this lack of information in that they call for determination of responses of wildlife to management activities in riparian areas including:

- Identification of wildlife species most impacted by various rotation lengths and treatments which emphasize conifer production.

- Determination of the effects of successional stage mixes on wildlife numbers and species composition.

- Determination of potential changes in wildlife communities under current forest practices.

- Determination of appropriate numbers and sizes of down logs and snags and the need for green trees for recruitment of future snags and down logs to provide for populations of dependent wildlife.

- Determination of effects on wildlife of various road density levels.

Similar, but somewhat fewer, information needs relative to management of riparian zones as fish habitat are identified as well.

The successional stage concept was utilized by the committee as the primary means of describing the responses of wildlife communities to changes resulting from timber harvest in the riparian ecosystem. Relating numbers of wildlife species to stage of vegetative development, which generally reflects the relative age of a forest stand, has been used by others (Wight, 1974; Thomas, 1979; Brown, in press) to display the changes in wildlife diversity that occur with plant succession following either a natural or man-caused disturbance. Unfortunately, there has been little work done to describe successional patterns in the riparian zone. Clearly there will be differences in these patterns related to stream order, since the width of the riparian zone (i.e., the area bordering streams or other bodies of water, characterized by a high water table and which may contain plants that require saturated soils during all or part of the year) will vary with stream size and with topography. For most streams of first through third order (generally types 5-3), particularly in western Washington, this zone is narrow, with upland vegetation often occurring immediately adjacent to the stream bank (Swanson, et al. 1982). In streams of these sizes, which constitute the majority of streams affected by forest practices in Washington, successional development patterns will be essentially the same as those of the uplands.

When patterns of wildlife diversity associated with successional stage are examined (as displayed in Figures 9 through 12 of the report), major differences in the numbers of wildlife species in different successional stages are evident. These differences reflect the fact that certain species find optimum habitat in a particular successional stage or stages. For birds and mammals, the greatest species diversity is associated with early stages of succession while greatest numbers of amphibians and reptile species are found in the old-growth stage. Old-growth stands often contain elements of the other successional stages such as small openings supporting a grass-forb community, a shrub layer, and shade-tolerant understory trees, as well as snags and down logs. These characteristics provide greater structural diversity than that present in younger successional stages; however, these elements do not normally occur in sufficient extent to provide habitat for the species which typically are associated with these successional stages. This is reflected in Figure 12, which illustrates the lowest number of species occurring in the old-growth successional stage. These relationships also suggest that the greatest overall species diversity will be found in areas where forest stands in a range of successional stages are present. It is important to note that most of the forest riparian ecosystems on state and private lands in Washington currently have experienced some type of natural or man-caused disturbance which has placed them in subclimax conditions. Because of the successional stage-diversity relationship, the composition of both plant and wildlife communities is continually undergoing change. Forest practices modify these changes primarily by speeding up the rate of succession or by truncating the successional process. Those species which favor early successional stages are positively affected, while those which prefer older stands, which do not develop under short rotation forestry, are negatively affected. Recognizing that these patterns occur, what is needed is an assessment of the likelihood that these species associated with older successional stages might be eliminated over extensive areas of forest land.

This assessment should take into account the fact that most state and private forest lands in Washington currently support younger successional stages, and that relatively large contiguous areas of older forests have been set aside in dedicated preserves of several types, and that current Forest Service plans call for setting aside additional acreage for wildlife and other purposes in most, if not all of the individual national forests within the state. A likely outcome of this assessment will be that populations of species associated with old growth forest have been reduced on state and private lands and that the likelihood of them being reduced to the point of being seriously threatened on a state-wide basis is low. A major research effort addressing the dependency of wildlife species in old-growth forests is currently underway in the U.S. Forest Service and should provide additional insights into many of these questions.

It should be recognized that most of the unique characteristics of the riparian zone that are important to wildlife continue to be present regardless of the composition of the riparian vegetation. They are characterized by linear shapes, high edge-to-area ratios, different microclimates from the uplands, periodic disturbance from flooding, variable soil moisture conditions, and standing water during all or part of the year whether an old-growth forest or a young conifer plantation is present.

As with wildlife, the response of fish to modifications of the riparian ecosystem is not well documented. The immediate effects of damage to stream channels and banks caused by logging through streams is apparent as are the blockages to fish passage caused by debris accumulations and improper installation of culverts and bridges. The immediate impacts of large sediment inputs and scouring of stream channels resulting from mass failures and debris torrents are also apparent. These problems have been addressed through the regulatory process and in fact are covered by regulations aimed at preventing their occurrence. Regulations have been updated as needed, with the latest revisions in the Forest Practice Act occurring in 1982. An inter-agency assessment of the adequacy of forest practice regulations in protecting water quality was made in 1980. The results indicated that when compliance requirements were met, water quality impacts did not occur. The interdisciplinary team conducting the assessment judged impacts from operations in compliance, to water important for fish use, to be relatively low overall. Even though the actual response of fish populations was not assessed, the conclusion that impacts were low is not surprising when viewed in light of the results of the Alsea Study (Moring and Lantz, 1975), which thoroughly examined the effect of logging on fish over a 14-year period in the coast range of Oregon. The study involved seven years of pre-logging fish and water quality measurements in three streams of similar size with similar fish population and habitat characteristics. Treatments applied to the streams were as follows:

<u>Needle Branch</u>

- Completely clearcut, followed by very hot slash burn during which fish in the stream were killed.
- No effort to protect the stream channel from logging activity.
- Riparian vegetation was cut or burned over the entire length of the channel.
- Some debris was cleared from the channels one to two years after logging.
- Sediment loads in the first year after harvest were 5.5 times pre-harvest loads; water temperature was elevated.

Deer Creek

- 220 acres of the 750-acre watershed was clearcut in small patches; slash was burned.

- Roads were constructed to each of the clearcut units.

- Buffer strips were left along all stream channels.

- Floods in 1965 and 1972 resulted in substantial inputs of soil and debris to the stream.

Flynn Creek

- Uncut control.

After seven years of post-treatment observations, the fisheries biologists conducting the study concluded:

- There were no changes in adult coho length frequencies, condition factors, sex ratios, or timing of spawning migration in streams with logged watersheds.

- Coho fry survival rates in streams in the logged areas were no different from those in pre-logging years.

- Juvenile coho populations or smolt yield were not adversely affected as a result of logging.

- Net coho production in Flynn Creek (control) remained essentially unchanged between pre- and post-logging years; net coho production in Needle Branch and Deer Creek increased during the post-logging period by 78 and 23 percent, respectively.

- Cutthroat biomass declined to an average of 30% of the pre-logging levels in Needle Branch. No change in cutthroat biomass occurred in Flynn Creek or Deer Creek.

- Average weights of juvenile cutthroat trout did not change significantly after logging.

- Average length of adult cutthroat trout changed from pre- to post-logging periods, as a result of increases and decreases in numbers of adults in the streams. Average length of fish decreased during summer of 1967, the time of highest water temperature. A slight decline (statistically non-significant) in average annual numbers of steelhead migrants was observed after logging in the Deer Creek watershed.

These results indicate that while some characteristics of the fish population changed under the significantly altered stream and riparian conditions, this severe treatment of Needle Branch, which goes well beyond what current forest practice regulations permit, did not result in destruction of the streams and their fish populations. The observation that coho salmon production actually increased in the streams in logged watersheds suggests that our understanding of all the factors which influence fish populations is incomplete. Recent work by Murphy and Hall (1981) and Bisson and Sedell (in press) has shown increased levels of salmonid biomass in streams flowing through logged areas compared to streams in forested areas, apparently the result of increased amounts of light reaching the stream, resulting in increased production of food for juvenile fish. Rapid recovery of streamside vegetation probably had an influence on the Alsea study results, as Summers (1982) working in similar vegetative types observed that shading equal to 50 and 75 percent of the prelogging level was achieved in five and nine years, respectively.

The intent of the foregoing discussion is not to suggest that forest management activities do not have the potential to damage streams and fisheries resources, but rather to point out that 1) the effects are at times much less severe that previously believed; 2) effects are mitigated to a large degree by existing forest practice regulations, 3) Fish population and habitat recovery from disturbance usually occur rapidly, and 4) our level of knowledge regarding forestry impacts on fish populations is incomplete, particularly when the overall response of the fish themselves is considered.

The recommendations that follow are not substantially different from those contained in the full Phase I report, and primarily indicate the need for emphasis in the area of documenting the status and response of fish and wildlife populations in forested riparian ecosystems, under the range of conditions that currently exist. This lack of documentation has resulted in some forest practices which have varied widely in the past. Post-logging stream cleanout rules provide an example of this change in emphasis. A few years ago, all stream debris was viewed as potential blockages to fish migration or as having the potential to cause downstream damage and was removed. Today with the function of debris as a fish habitat component recognized, the cleanout requirements are directed mainly at the debris introduced during the logging operation. While recent studies are improving our understanding and leading to improved guidelines (Bilby, 1984), many information needs remain with regard to debris management. These include debris size requirements relative to stream size, persistence of residual debris in second-growth forests, and the effectiveness of hardwood compared to conifer debris, to name a few. Studies addressing these questions are necessary if we are to understand the range of needs and management opportunities available for providing necessary amounts and types of debris through time.

The specific recommendations that should be of highest priority in Phase II are as follows:

<u>Wildlife recommendations:</u>

Food and Cover

- Field assessments to identify species impacted by various rotation lengths or treatments which emphasize conifer production in riparian ecosystems.

- Field studies be conducted to document the effects of several successional stage mixes on wildlife numbers and species and of the range of conditions that provide suitable food and cover for species affected under current conditions.

- Determination be made of the changes in the wildlife community which will occur if current forest practices in the riparian ecosystem are continued; identification of any species that might be eliminated over large areas of forestland should be made in conjunction with these determinations. (The current U.S. Forest Service research program addressing wildlife habitats in old-growth forests should be monitored as it constitutes a major effort in attempting to determine to what degree wildlife species may be dependent on old-growth forests.)

Snags and down woody material

- Field assessments be made of the current population status of snag-dependent species on state and private lands. If population reductions are occurring, assess the likelihood of elimination of snag-dependent wildlife over large areas of forest land, and define acceptable population levels.

  - If above determinations indicate a serious problem exists, recommend silvicultural systems and treatments, and logging methods that provide opportunities for the retention of snags and down logs, or green trees for future snags and down logs, at levels adequate to maintain acceptable populations of snag-dependent wildlife.

Disturbance and Harassment; Travel within Riparian Ecosystems

- A determination be made of the effects on wildlife use of habitat by various road density levels and types and levels of traffic and human activity.

  - If road densities and human disturbance are unacceptable, develop alternatives for road placement, as well as guidelines for management of existing roads, to eliminate or reduce disturbance to wildlife.

- Encourage continued and expanded development by the Game Department of cooperative road management plans with landowners that will provide for quality hunting and reduced disturbance to wildlife.

Documentation of forest practice influences on wildlife populations in riparian areas should be the basis for modifying forest practice regulations and should consider modifications that reduce negative influences as much as those which might enhance beneficial ones.

Fisheries Recommendations

While this study has identified the potential of forest practices to negatively impact water quality and associated stream productivity, much of the research referenced dealt with water quality changes but did not assess effects on the fish populations themselves. At the same time, the study has referenced some research showing positive responses in fish populations as a result of forest practices. The response of fish to changed habitat seems to be a function of the particular environmental variable affected. For example, a number of recent studies that examined fish populations following streamside vegetation removal show increased numbers and/or growth rates of salmonids, with the increases being attributed to increased in-stream food production as a result of the increased light reaching the stream. The degree to which such increase might be offset by other effects such as reductions in amounts of stream LOD has not been examined. The habitat variables influenced by forest practices which appear to be most important in modifying fish populations are:

- water temperature
- levels of light reaching the stream
- sediment levels
- organic debris - type and amount

It is necessary to determine how fish are responding to current forest practices, with the emphasis on understanding the interactions between modification of these different habitat components. After documenting these responses to habitat change, adequacy of existing forest practice regulations should be assessed and modified if necessary. Specific recommendations are:

- Phase II should develop an outline for research, with recommendations to the Forest Practices Board for its accomplishment, to provide information on the interactions between these variables as the basis for development of methods to maintain or enhance fish populations, concurrent with forest management.

- Develop additional information on the role of large organic debris as a component of fish habitat including:

  - debris size in relation to stream size
  - effectiveness and persistence of residual debris and rates of recruitment of new debris in relation to age of the riparian forest
  - amounts and distribution of debris that provides optimal levels of stream productivity
  - structural alternatives or equivalents of large woody debris

- Assess the effectiveness of 1982 forest practice rule changes directed at reducing the incidence of mass failures. If results indicate a need exists, develop recommendations to further reduce the likelihood of mass failures and their impacts on streams, lakes and ponds.

- Assess the current status of fish populations in streams representing the range of riparian conditions occurring on state and private lands in Washington.

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