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Appendix B
Technical Report Summaries

Plum Creek Timber Company (Plum Creek) developed 13 technical reports, 3 white papers, and 1 best management practice policy to support the development of this Environmental Impact Statement. These documents were introduced in Chapter 2, and are summarized in this section. To receive complete copies of any of these items on CD-ROM, send $10.00, by check or money order, to Mike Jostrom at Plum Creek Timber Company, P.O. Box 1990, Columbia Falls, MT 59912.

Technical Reports	
#1	Implementation of a Method to Detect the Presence of Bull Trout
#2	Factors Affecting the Distribution and Abundance of Bull Trout: An Investigation at Hierarchical Scales
#3	Surface Erosion And Mass Wasting Assessment and Management Strategies for Plum Creek's Native Fish Habitat Conservation Plan
#4	An Ecological Classification Integrating Uplands and Riverine/Riparian Habitats Applied to the Thompson River Basin, Montana
#5	Goat and Piper Creeks Watershed Analysis
#6	Summary of Regulatory and Voluntary Programs for Protecting Bull Trout on Forest Lands within Plum Creek's Aquatic Habitat Conservation Planning Area
#7	Design of Effective Riparian Management Strategies for Aquatic Resource Protection in Montana, Idaho, and Washington
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Thompson River Riparian Reconnaissance and Monitoring	
Grazing Best Management Practices	

Technical Report #1

Implementation of a Method to Detect the Presence of Bull Trout

Overview

The purpose of Technical Report #1 is to describe the results of a new survey method to determine bull trout populations in streams and watersheds. Scientists working with Plum Creek Timber Company implemented this statistically based survey method on 43 streams in Idaho, Montana, and Washington in 1993 (82 more streams were surveyed from 1994 to 1997). Six of the surveyed streams contained bull trout. Three of those streams had previously been surveyed by the U.S. Forest Service with no detection of bull trout. Comparison of the old method with the one used here indicates that the old method was not as rigorous.

In addition to the population density survey, scientists collected data about the type of habitat surrounding bull trout streams. This information could eventually be used to predict the presence or absence of bull trout in streams (see Technical Report #2).

Key Points

Technical Report #1 describes the methods used in the survey for bull trout in terms of the following:

- Sampling design
- Site selection
- Data collection

The report also contains a table listing the fish species captured in the sampling areas. The results indicate that bull trout can be found in watersheds with a history of mixed land uses. Therefore, the degree or extent of historic land use may not predict the presence of bull trout.

Supporting Technical Information

From June through October 1993, 43 streams in Idaho, Montana, and Washington were surveyed for the presence of bull trout. The sampling design uses a probability of 95 percent, which is higher than the 80 percent probability typically used in fish surveys. Sampling sites were selected based on the historical range of the bull trout. Various habitat measurements were reported to describe any correlations between habitat characteristics and fish abundance.

Sampling Design

The sampling design is based on the following:

- Minimum population density
- Distribution of bull trout in streams
- Probability of detection

The expected **minimum population density** of bull trout was based on a review of available literature. The lowest reported density for a population of bull trout is 0.25 fish per kilometer (fish/km). This density was used for the survey.

The **distribution of bull trout in streams** is based on a model called the Poisson. This model, which is illustrated as a curve on a graph, is based on the assumption that bull trout are rare.

The Poisson curve shows how many sample sites are required to get the desired **probability of detection**. As discussed, the probability of detection for this survey is set at 95 percent. To achieve this probability, it was determined that twelve, 100-meter-long, randomly located sections (transects) would need to be sampled in each 10 km stream reach.

Site Selection

According to researchers, juvenile fluvial (river dwelling) and adfluvial (lake and river dwelling) and resident bull trout are generally found in smaller watersheds. By looking on a map, streams can be grouped into **orders** based on their size. To target stream reaches that might contain bull trout, only second- to fourth-order watersheds (those containing smaller streams) were selected for sampling.

Data Collection

Four types of data were collected:

1. Site description
2. Fish presence
3. Habitat measurements
4. Stream ecological classification

The **site description** involves the physical attributes of the site, including date, weather, location, stream width and depth, and valley width and type. The description also includes temperature and streamside vegetation information.

Sampling for **fish presence** was conducted by snorkeling and single-pass electrofishing in the 100-meter site. Species were grouped into size classes and counted.

Habitat measurements were taken of each sampling site. The measurements included wetted channel width, depth of pools, percent of surface fine sediment, amount of large woody debris, amount of woody debris and boulder cover, percent of streambank undercut, and percent of canopy cover and vegetation overhang.

A **hierarchical classification** was used to identify reaches of distinctive form, function, and ecological potential. For more information about this classification, see Technical Report #4: *An Ecological Classification Integrating Uplands and Riverine/Riparian Habitats Applied to the Thompson River Basin, Montana.*

Conclusion and Implications

The six bull trout streams identified by the survey had varied land management histories ranging from essentially undisturbed watersheds to watersheds with many decades of human disturbance. The same range of disturbance was also noted in watersheds where no bull trout were detected. Bull trout observed ranged from the 0 to 75 millimeter (mm) size class to the 225 to 300 mm size class.

Scientists found bull trout in watersheds with diverse management histories. These results suggest that past disturbance does not reliably predict the presence of bull trout. Since bull trout were found in streams that were previously reported to not have bull trout populations, some watersheds may need to be surveyed again.

Future surveys will likely use the method applied in this survey because of the high degree of statistical confidence in the results. A map of survey results and known bull trout distribution within the project area is provided in the technical report.

Technical Report #2

Factors Affecting the Distribution and Abundance of Bull Trout: An Investigation at Hierarchical Scales

Overview

Bull trout *(Salvelinus confluentus)* has recently been listed as threatened by the U.S. Fish and Wildlife Service. To help this species recover, it is important to first understand what factors affect bull trout distribution and population density. This understanding will form the basis of the Habitat Conservation Plan (HCP) proposed by Plum Creek Timber Company, L.P. The purpose of Technical Report #2 is to determine, based on the kinds of factors that affect bull trout populations, whether management should be region-wide or site-specific.

Key Points

To determine the large-scale habitat factors affecting bull trout populations, we studied the relationship between the occurrence of bull trout and several physical and biotic factors. Bull trout occurred significantly more often at sites with the following characteristics:

- Lowlands and mountain valleys where stream channels are unconfined and have shallow stream gradients
- Undercut banks
- Large gravel substrates
- Large, deep pools without extensive canopy cover
- Wood and boulder cover in the stream
- Trees and shrubs are dominant riparian vegetation

Supporting Technical Information

We surveyed 1,057 randomly selected sites from 93 streams within 18 major drainages throughout Washington, Idaho, and Montana for the presence of bull trout. Then, we correlated the survey results to the land types that contained bull trout. Through this analysis, we discovered that there are significant correlations between bull trout numbers and the physical characteristics at the site, stream, and basin scales of analysis. However, the important variables affecting bull trout populations varied across different scales of analysis.

Bull trout occur more often in lowlands and valleys and in sites with undercut banks, large gravel substrates, deep pools, and where trees and shrubs are the dominant riparian vegetation. Bull trout population density increased as the amount of canopy cover decreased. Bull trout also avoid areas that contain brook trout populations.

Our studies indicated bull trout distribution is associated with large-scale habitat characteristics (i.e., valley bottom type and basin size), while population density is most strongly associated with small-scale features that vary among watersheds. Therefore, life history requirements and localized landscape patterns drive bull trout distribution while population density is influenced by the manner in which habitat diversity is expressed within specific basins.

Conclusion and Implications

The results of this study indicate bull trout distribution is related to the habitat classification of stream segments, not the overall classification at a watershed level. Therefore, bull trout do not (and historically did not) occur everywhere, and land management plans for enhancing bull trout populations should be tailored and site-specific, and not be implemented region-wide.

Technical Report #3

Surface Erosion And Mass Wasting Assessment and Management Strategies for Plum Creek's Native Fish Habitat Conservation Plan

Overview

Erosion is defined as the movement of soil or rock by water, wind, ice, or gravity. Although erosion takes place naturally, the speed and amount of erosion can be increased by human activities, such as grazing, logging, or farming. Technical Report #3 has four objectives:

1. Summarize the impacts of historical logging and road construction practices in the Pacific Northwest
2. Discuss current regulations and the protection they provide
3. Evaluate the effectiveness of current Best Management Practices (BMPs) in controlling erosion
4. Present general strategies and opportunities to better address erosion in Plum Creek watersheds

Key Points

The following points summarize the key findings of this Technical Report:

- BMPs and Streamside Management Zones (SMZs) effectively control surface erosion and sediment delivery from hillslope sources.
- Roads produce nearly all management-derived surface erosion and sediment delivery to streams. Adding drainage to roads can substantially reduce sediment delivery.
- Mass wasting is not a dominant erosional process in the project area but can be locally significant.

Supporting Technical Information

Two basic types of erosion were evaluated in Technical Report #3: surface erosion and mass wasting. **Surface erosion** occurs when water flows across a soil surface and fine particles are carried down the slope and into the stream. For the purpose of this technical report, surface erosion was partitioned into two forms: hillslope erosion and road erosion. **Mass wasting** (landsliding) occurs when soil is violently removed from the hillside as a unit. This mass movement of the soil is often triggered by too much water on a steep slope, which allows gravity to overcome the forces that would otherwise keep the soil on the slope.

The salmonid species addressed in Plum Creek's Native Fish Habitat Conservation Plan (NFHCP) and in the Environmental Impact Statement depend on gravel stream bottoms for spawning and rearing. Excessive sediment can limit this part of salmonid habitat. It is important for Plum Creek scientists to understand the most effective way to preserve spawning and rearing habitat.

Sediment Contribution from Hillslopes

Based on erosion studies in 15 watersheds, surface erosion from hillslopes was rarely observed when BMPs were implemented and streamside vegetative buffers were maintained. This finding agrees with other scientists' findings and state audits. While hillslope erosion has not been shown to be a substantial process of concern in the Project Area generally, it can be important in local areas.

Sediment Contribution from Roads

Roads produce nearly all of the management-derived surface erosion to streams. Most of this sediment delivery occurs at stream crossings and from roads adjacent to streams.

Because most roads in the Project Area were constructed prior to the advent of BMPs, opportunities exist to reduce sediment delivery to streams. A review of 11 analyses found that sediment delivery could be reduced by 25 to 85 percent by adding drainage around stream crossings.

Information in the technical report can be used to assess the benefits of adding drainage to streams as part of the NFHCP. Information is also provided that can also be used to assess the impacts of additional road construction.

Mass Wasting in Plum Creek Watersheds

Mass wasting (landsliding) is the dominant form of erosion in many forested watersheds in the Pacific Northwest. However, rates of mass wasting in the Project Area are substantially lower than in western Washington and immediately east of the Cascade Mountains. Although the rates are lower, mass wasting can be a locally significant erosional process in the Project Area.

Conclusion and Implications

Increased sediment in streams has an adverse impact on the habitat of many salmonid species. Human-caused erosion can increase sediment delivery to these streams. Surface erosion and mass wasting rates can be effectively minimized by implementing BMPs and SMZs.

Technical Report #4

An Ecological Classification Integrating Uplands and Riverine/Riparian Habitats Applied to the Thompson River Basin, Montana

Overview

Effective land management requires an understanding of climate, geology, vegetation patterns, landforms, soils, and streams. Ecological classification provides a framework and descriptive attributes from which interpretations regarding habitats and effects of land uses can be made. The purpose of Technical Report #4 is to describe a classification system developed for the Thompson River Basin. This system can be used as a tool to assess the ecological potential and the existing condition of riparian habitat.

Key Points

The table below identifies the levels of hierarchy used to classify the Thompson River Basin.

Ecoregion	
Geologic District	
Subsection	
Uplands	**Bottom-Lands**
Landtype Association	Valley-Bottom Landtype
Landtype	Valley-Bottom Type
Habitat Type	State
Vegetation Type	Valley Bottom Landform
	Riparian Vegetation Type

Supporting Technical Information

Classification is used to identify areas with similar functions that respond to forest management in predictable ways. More than 70 years ago, scientists began to develop classification systems for landforms. Throughout the years, several classification systems have been adopted, modified, and rejected. The classification system developed in this report is based on work that began in the 1970s and takes advantage of recent thought that integrates upland and riparian habitats. The classification adopted for the Thompson River Basin, shown as a table under *Key Points*, is summarized below.

Ecoregion

Ecoregions are the broadest classification, and can either be relatively similar throughout their range or have great variation. Ecoregions provide a general framework for nesting lower classification levels. The Thompson River Basin is entirely within the *Northern Rockies Ecoregion*.

Geologic District

Geologic districts are areas with distinctive lithology (rock types) or parent material (for example, granite versus metamorphic). Geologic districts correspond with distinctive plant communities (which have a preference for soil types and minerals), specific stream bottom composition (sand versus gravel), and potentially different water quality. The Thompson River Basin lies within a single *metasedimentary geologic district,* which is typical of the *Northern Rockies*

Ecoregion. The potential for slope stability and habitat for certain plant species is similar to those in the Swan River Basin.

Subsection

Subsections are lands that evolved in response to distinctive geomorphic processes that correlate with landscapes of distinctive form—mountains sculpted by alpine glaciers are distinguished from mountains dissected by streams and from more gentle terrain shaped by continental glaciation. In the Thompson River Basin, four subsections were distinguished.

Subsections can be further separated into two basic geomorphic groups: uplands and bottom-lands. Uplands within a subsection, defined by geomorphic parameters, are further stratified at successively larger scales into landtype associations, landtypes, habitat types, and vegetation types. Bottom-lands within a subsection are stratified as valley-bottom types, states, valley-bottom landforms, and riparian vegetation types. Valley-bottom types denote bottom-lands within a subsection with more distinctive ecological potential. States are condition classes based on channel morphology that may change in response to management. Changes in state lead to predictable changes in valley-bottom landforms and riparian vegetation types. The condition of riverine/riparian habitat can be quantified in terms of the distribution of states for a stream reach or a watershed.

Conclusion and Implications

Ecological classification is a tool to organize landscapes into areas with distinctive ecological potential. In the Thompson River Basin, results of the classification are being used to group upland and riverine/riparian habitats, to assess the similarity of watersheds, to screen for landscape hazards, and as a foundation for more intensive watershed and aquatic analyses (See Technical Reports #8 and #11).

Technical Report #5

Goat and Piper Creeks Watershed Analysis

Overview

In May 1997, Plum Creek Timber Company, L.P., initiated a watershed analysis in the Goat Creek and Piper Creek basins, both of which are tributaries to the Swan River in northwestern Montana. Watershed analysis is a process to address the cumulative effects of forest practices on two areas of public resources: fish habitat and water quality. The potential and existing resource conditions are described in the report, as are the relevant physical processes that affect the resource condition. The purpose of this report is to present results of the resource assessment and provide documentation and justification for the identification and management of sensitive areas.

Key Points

Watershed analysis is conducted by studying separate **modules.** The modules studied in this Technical Report include the following:

- Mass wasting
- Surface erosion
- Hydrology
- Riparian function
- Channel condition
- Fish habitat

Once the analysts had worked through the modules, the information was brought together with the data from other modules to develop a more complete picture of the watersheds.

Supporting Technical Information

Plum Creek owns 22.1 percent of the analysis watersheds. The U.S. Forest Service manages 64.8 percent of the analysis area and the State of Montana manages 12.8 percent. Private lands comprise only 0.3 percent of the area. The dominant land use is forestry. In addition, both basins are used by the public for recreation such as hiking, hunting, fishing, and firewood cutting. This section summarizes the findings of the watershed analysis in each of the subject modules.

Mass Wasting. Piper and Goat Creek watersheds have steep slopes in a glaciated area. Although many avalanche chutes, rockfalls, and one large deep-seated landslide occurred naturally, only five small mass wasting sites were linked to forest management activities. These landslides resulted from steep cutslopes or concentration of road runoff onto steep slopes. Few landslides have delivered sediment directly to streams. Forest management on steep slopes requires caution to avoid landslide hazards.

Surface Erosion. Surface erosion from hillslopes and roads occurs when soil is exposed to surface water flow. Although there are local areas of soil disturbance on recently harvested hillslopes, field results show that Best Management Practices (BMPs) prevented sediment delivery to streams. The road erosion assessment compared road sediment delivery to natural background sediment. For the Goat Creek watershed, roads produce 39.3 tons of sediment per year, or 11 percent above

background. In the Piper Creek watershed, roads contribute 25.5 tons per year, or 24 percent above background. Therefore, road erosion is rated as a low hazard. Most of the sediment delivered to streams occurs at key points along roads. In the Goat Creek watershed, the worst five crossings deliver 70 percent of the total sediment delivered by roads in the basin. Sediment delivery may be reduced by addressing stream crossings.

Hydrology. This module evaluated how streamflows have been altered by timber harvest. Little historical streamflow information is available for these basins. However, hydrologic model simulations and stream measurements suggest that there are no significant effects from forest management. A 5-year monitoring program is proposed to address the uncertainty, especially in terms of the distribution and melt rates of spring snowpack.

Riparian Function. This module evaluated the condition of riparian areas based on their ability to supply large woody debris (LWD) to stream channels and provide shade to maintain stream temperatures. Most stream segments within the watersheds met or exceeded the Washington Forest Practices Board criteria for LWD and shade. If the Montana stream management zone guidance is used for harvest here, it would work in most instances but may need to be modified for areas where the stream channel migrates across a wide zone. Further research is needed to determine the actual effects of timber harvest on riparian function.

Channel Condition. The geologic history of the area was used to determine the stream channel types and their potential sensitivity to forest management. The streams were classified into Geographic Mapping Units. These units form borders around areas of high value and lower value fish habitat and indicate the relative sensitivity of stream segments to forest management practices.

Fish Habitat. Goals of the fish habitat module are to document existing and historic fish distribution, assess current habitat conditions, identify important habitat, and identify impacts to habitat from land management. Trout and char species in the analysis area include brook, bull, cutthroat, and rainbow trout. Brook and rainbow trout are non-native species, which were stocked as early as 1926. Although natural barriers to fish passage are present, no man-made barriers to fish movement were found in the analysis area. Fish habitat conditions varied from fair to good in the analysis watersheds and were largely a function of channel type rather than forest management activities.

Conclusion and Implications

Stream channels are shaped by a number of variables that interact to create a unique stream segment. Some variables, such as the gradient, valley confinement, and drainage area of a stream, are relatively unchanged by human activities. Other variables, such as the amount of coarse and fine sediment, the amount of large wood in the stream channel, and the volume and timing of flood events, can be influenced by management activities. Gathering this information allows managers to develop management practices to minimize or prevent problems in sensitive areas.

Technical Report #6

Summary of Regulatory and Voluntary Programs for Protecting Bull Trout on Forest Lands within Plum Creek's Aquatic Habitat Conservation Planning Area

Overview

Throughout the last 190 years of western European settlement in the northwestern United States, various events have impacted water quality and native fish, including bull trout (*Salvelinus confluentus*). From trappers in the early 1800s to 20th-century livestock grazing, fish harvest, and timber practices, the needs of native fish were historically ignored.

During the past 25 years, timber harvest practices and other land uses began to be regulated in the United States. The objective of Technical Report #6 is to summarize and evaluate regulatory and voluntary programs for protecting bull trout habitat on forestlands in the vicinity of Plum Creek's ownership.

Key Points

Four major points emerged from the analysis of current regulations:

- The Forest Service manages most bull trout streams.
- About half of the bull trout streams that cross Plum Creek lands are "less sensitive" to forest management. This means that these stream segments are used by bull trout for foraging, migratory, and over-wintering habitat. Spawning and juvenile rearing habitat would be considered "more sensitive" to forest management.
- National Forests in Plum Creek's bull trout watersheds have conservative aquatic resource protection strategies.
- Numerous aquatic resource protection measures are already embodied in Plum Creek's management.

Supporting Technical Information

Various state forest practice rules, federal laws, Best Management Practices, and aquatic resource protection strategies have created a patchwork of regulations surrounding bull trout habitat on Plum Creek's lands. These regulations are summarized in Technical Report #6. The following discussion summarizes the key points that can be made from an analysis of these regulations.

Forest Service Management

Plum Creek has significant ownership in bull trout drainages throughout the Pacific Northwest. However, these are a fraction of the total lands within bull trout watersheds, and the Forest Service manages most of the remainder. Because of the checkerboard pattern of Plum Creek ownership, management of bull trout watersheds is tightly interwoven with Forest Service policy. If the amount of land owned by Plum Creek is compared to the amount owned by the Forest Service, the federal government's role is larger than Plum Creek's in protecting bull trout habitat.

Less Sensitive Stream Miles

Although the raw acreage of Plum Creek lands compared to Forest Service lands is important in understanding the regulatory environment, it is also necessary to review the type of bull trout habitat present on Plum Creek property. About half the total miles of bull trout streams that cross Plum Creek's land provide foraging, migratory, and over-wintering habitat. These kinds of habitat are typically less sensitive to the kinds of forest management activities that can potentially affect spawning and juvenile rearing habitat. For example, sediment input that may result from forest management is more critical in spawning than non-spawning areas.

Conservative Protection Strategies

After reviewing the regulations currently in place on lands in the Plum Creek Project Area, it appears that adjacent National Forests in the Planning Area have recently adopted highly conservative aquatic resource protection strategies. This provides an opportunity for Plum Creek to complement the federal strategies of maximizing benefits to bull trout while maintaining profitability and shareholder value.

Numerous Protection Measures

Plum Creek's environmental management system already incorporates numerous aquatic protection measures. These measures include state forest practice rules, Environmental Principles, watershed analysis, and formal conservation agreements with the federal government. Collectively, these measures help address bull trout habitat needs during forest management activities.

Conclusion and Implications

The legacy of past land use and its management impacts on bull trout has undoubtedly contributed to the current depressed state of many stocks. Included in these are past impacts from forest management activities. Current BMPs now provide considerable protection for aquatic resources. However, current science does not provide high certainty of the cause and effect relationships between forest practices and resource conditions. Continued experimentation with different land management approaches is still needed. Plum Creek has a demonstrated commitment to the use of best available science for developing innovative solutions to challenging resource management problems. This philosophy will be crucial for identifying remaining bull trout sensitivities not covered under current forest management systems, and for developing workable management approaches to address these sensitivities.

Technical Report #7

Design of Effective Riparian Management Strategies for Aquatic Resource Protection in Montana, Idaho, and Washington

Overview

A complex issue facing the forest industry is managing riparian areas. These sensitive areas surround streams and affect fish habitat in a number of ways. Scientists disagree on the amount of riparian area required to maintain a healthy fish habitat. Technical Report #7 does not provide standards and guidelines, but does provide the foundation for answering the question: "how much riparian buffer is enough?" The objectives of the report are as follows:

1. Describe differences in fish resource sensitivities within a watershed
2. Design a way to evaluate the results of various riparian management scenarios
3. Apply this tool to evaluate existing management strategies
4. Identify gaps in existing strategies

Key Points

A successful solution to riparian management balances habitat needs of fish with economic needs of landowners. To reach this balance, we need to better understand riparian structure and function:

- Where are fish most vulnerable to management in riparian areas?
- How much woody debris is needed?
- What is the acceptable risk to fish populations?
- What other riparian functions are critical to fish habitat?

Supporting Technical Information

Riparian vegetation has two main influences on a stream: physical and biological. The **physical** influences concern the structure provided by shrubs, grass, trees, and their root systems. This structure affects the shape of the stream channel, the temperature of the water, the amount of sediment reaching the stream, and the diversity of the habitat. The **biological** influences concern the flow of nutrients through the system. Nutrient use and input is based on the cycling of organic matter in the system, which involves such steps as the decay of vegetation, death of post-spawning fish, and the uptake of these nutrients by soil and aquatic insects. Understanding physical and biological influences is critical to managing riparian areas.

Where are Fish Most Vulnerable to Riparian Management?

All portions of the stream network throughout a watershed influence the quality of the stream for fish habitat. The simplest approach to riparian management is to establish a **riparian buffer**, a strip of land on either side of the stream that is free of all timber harvest, at a set width along all streams in the watershed. The problem with this approach is that it assumes that all riparian areas are equally important to fish habitat.

We have found that the interplay between riparian forests and channel conditions can

change significantly along a stream and that a tailored management approach is both suitable for the fish and acceptable to the land owner.

How Much Woody Debris is Needed?

Large woody debris (LWD) is an important physical contribution from riparian forests to the stream. LWD creates pools, reduces stream velocity, traps spawning gravels, and provides shelter from predators. To decide how much LWD is needed for a particular stream, the landowner must look at how sensitive that particular stream is to a loss of LWD. Some streams have naturally low LWD loads, while others have relatively high loads, and this is largely determined by the character of the riparian forest adjacent to the stream. The amount and quality of fish habitat that a given stream reach provides is also variable, and is greatly influenced by channel gradient. Certain stream reaches have a high sensitivity to LWD loss, while others are relatively less sensitive. Technical Report #7 evaluates the degree of channel and habitat sensitivity to wood loss for different channel types, and estimates how much LWD is produced as the result of different management options.

What is the Acceptable Risk to Fish Populations?

Every planning process involves an assessment of risk. To conduct the management analysis in this Technical Report, we made several assumptions about the cause and effect relationships between a given riparian protection level and the resulting habitat change. One assumption is that the selected management strategy would be used throughout the entire watershed. For example, if Montana's existing state riparian management rules were applied throughout an entire watershed, most riparian stand types would contribute enough LWD to maintain the amount and sizes within natural levels. However, land ownership is intermingled, and more than half of the stream miles flow through U.S. Forest Service lands, which feature riparian buffers that provide more protection than what the analysis shows is needed. The end result of this land use mixture is reduced risk to fish habitat across the entire watershed.

What Other Riparian Functions are Critical to Fish Habitat?

Riparian areas provide more than LWD; they also provide shade, canopy closure, bank stabilization, nutrients, filtration of fine sediments, and flood energy dissipation. Based on a literature review and the analysis in the Technical Report, it appears that in most cases an adequate riparian buffer for LWD is also adequate for other riparian functions. For example, bank stabilization can be achieved by a continuous buffer of riparian trees or by discontinuous buffers with a near-stream equipment exclusion zone.

Conclusion and Implications

Several opportunities are available for landowners to manage their land for economic and fish habitat benefits. The goal of successful riparian management is to tailor timber harvest to match the riparian area with the localized fish habitat needs. This approach optimizes habitat conservation for the fish and economic gain for the landowner.

Technical Report #8

Synthesis of Watershed Analysis and Ecoclassification at a River-Basin Scale for the Conservation and Management of Aquatic Ecosystems

Overview

Federal and state laws typically manage aquatic ecosystems by establishing a standard-width **buffer zone** on either side of a stream. Buffer zones are limited because they do not account for variation in an individual watershed. Some buffer zones are too small to allow proper riparian function, and some are too large and exclude management for harvest, disease control, and fire prevention.

A better approach is **watershed analysis**, which is an extensive analysis of stream conditions that examines the cause-and-effect relationship among streamside vegetation, fish habitat, and water quality. However, watershed analysis is costly. The goal of Technical Report #8 is to develop a watershed analysis framework, based on classification of the parts of a watershed, that can be applied cost-effectively to different watersheds.

Key Points

Designing a framework for watershed analysis confirmed two conclusions:

1. A Geographic Information System (GIS)-based classification can be used to group physically similar channel segments.
2. These classifications, called **guilds**, can be used as a template to characterize other watersheds.

Supporting Technical Information

When you perform watershed analysis across similar landscapes, common patterns begin to emerge. Certain types of channel shapes and vegetation communities typically occur together. These patterns are based on the landforms (geomorphic characteristics) of a particular section of a stream. Our work is based on the premise that geomorphic processes generally determine how the stream channel functions and what kind of fish habitat the stream provides.

GIS-Based Classification

Geomorphic processes are predicted by landscape-scale features, such as geology, typical erosion processes, drainage patterns, and climate patterns. Aquatic organisms are found where the geomorphic processes provide habitats that are ideal for various species' needs. The GIS-based classification is used to identify groups of channel segments that have similar fish habitat, fish distribution, and sensitivity to land management activities. These geomorphic groups are called **guilds**.

Guilds are the building-block group of our ecoclassification approach. This classification approach includes the geomorphic characteristics of a stream that influence the presence of fish habitat, such as the following:

- Drainage area
- Stream size
- Valley bottom slope (steepness)
- Dominant substrate
- Lithology and landform class
- Principal riparian vegetative community type

GIS is used to identify particular guilds and locate the guilds on a map. The map then becomes a tool for resource management in a particular watershed.

Guilds as a Template for Other Watersheds

As described above, guilds can be effectively used to predict the presence of fish and identify sensitive habitat areas. Therefore, one guild type may be appropriate for one type of timber harvest, while another guild type is not.

By using the guild classifications we identified, landowners can better manage an entire watershed based on the needs of the individual guild types found within it. Although our study was limited to the Swan River Basin, this classification is appropriate for watersheds that have similar climate, geology, geomorphic processes, and vegetation.

Conclusion and Implications

Effective management depends on knowing site-specific conditions. Watershed analysis is a good tool for defining site-specific conditions. The guilds identified in this Technical Report can be used to select appropriate management for specific areas of a stream. This approach accomplishes two goals:

1. Site-specific management is used to provide better habitat for species.
2. Landowners are not required to follow buffer widths that are too large and prevent economic use of the land.

Landowners can use the classification and analysis in this Technical Report to predict the distribution of rare or threatened species based on the habitat conditions. The classification can also be used by other industries, such as mining, grazing, or agriculture.

Technical Report #9

Swan River Basin Ecological Classification

Overview

Effective land management requires an understanding of climate, geology, vegetation patterns, landforms, soils, and streams. Ecological classification provides a framework and descriptive attributes from which interpretations regarding habitats and effects of land uses can be made. The purpose of Technical Report #9 is to apply the classification to the Swan River Basin in northwest Montana. This classification can be used as a tool to assess the ecological potential and the existing condition of riparian habitat.

Key Points

The table below identifies the levels of hierarchy used to classify the Swan River Basin.

Ecoregion	
Geologic District	
Subsection	
Uplands	**Bottom-Lands**
Landtype Association	Valley-Bottom Landtype
Landtype	Riparian Landtype
Habitat Type	
Vegetation Type	

For more information about the definitions of each of these classification levels, see Technical Report #4, *An Ecological Classification Integrating Uplands and Riverine/Riparian Habitats Applied to the Thompson River Basin, Montana.*

Supporting Technical Information

The Swan River Basin falls within a single **ecoregion** (Northern Rockies) and **geologic district** (metasedimentary). The following three **subsections** were defined by geologic structure:

1. Alpine glacial sedimentary scarp slope
2. Alpine glacial sedimentary dip slope
3. Continental glacial sedimentary valley

Eleven **landtype associations** were identified by the Flathead National Forest. These landtype associations are groups of related **landtypes** that are distinguished by landforms, soil patterns, and climax plant communities. A total of 46 landtypes were identified.

Twelve **major habitat types** and 26 **minor habitat types** were identified from previous research. **Riparian landtypes** are defined by valley-bottom gradient, dominant streambed materials, and dominant vegetation community type. Riparian landtypes were mapped and described for Forest Service lands in the Flathead National Forest. In a cost-share agreement with Plum Creek Timber Company, the Flathead National Forest extended the riparian landtype mapping to private lands in the Swan River Basin and to the Mission Mountain Wilderness.

Conclusion and Implications

A Geographical Information System (GIS) was used to compile the land classification on map layers, plot maps, and create map data summaries. Maps, descriptions, and

data summaries are provided in this technical report for each hierarchical level.

Ecological classification is a tool to organize landscapes into areas with distinctive ecological potential. In the Swan River Basin, results of the classification are being used to group upland and riverine/riparian habitats, assess the similarity of watersheds, screen for landscape hazards, and provide a foundation for more intensive watershed analysis.

Technical Report #10

Thompson River Basin Ecological Classification

Overview

Effective land management requires an understanding of climate, geology, vegetation patterns, landforms, soils, and streams. Ecological classification provides a framework and descriptive attributes from which interpretations regarding habitats and effects of land uses can be made. The purpose of Technical Report #10 is to apply the classification to the Thompson River Basin in northwest Montana. This classification can be used as a tool to assess the ecological potential and the existing condition of riparian habitat.

Key Points

The table below identifies the levels of hierarchy used to classify the Thompson River Basin.

Ecoregion	
Geologic District	
Subsection	
Uplands	**Bottom-Lands**
Landtype Association	Valley-Bottom Landtype
Landtype	Valley-Bottom Type
Habitat Type	Valley Bottom Landform
Vegetation Type	Riparian Vegetation Type

For more information about the definitions of each of these classification levels, see Technical Report #4, *An Ecological Classification Integrating Uplands and Riverine/Riparian Habitats Applied to the Thompson River Basin, Montana.*

Supporting Technical Information

The Thompson River Basin falls within a single **ecoregion** (Northern Rockies). This ecoregion includes parts of two sections of the Northern Rocky Mountain Forest–Steppe–Coniferous Forest–Alpine Meadow Province:

1. Flathead Valley section
2. Belt Mountain section

A single **geologic district** was identified (metasedimentary). Four **subsections** were defined by geologic structure including alpine glaciated lands, fluvial lands, continental glaciated erosional lands, and continental glaciated depositional lands. These subsections are further divided into **landtype associations**, as follows:

1) Alpine glaciated lands
   a) Cirque and rocky ridge
   b) Glacial basin
   c) Glacial trough
   d) Moraine
2) Fluvial lands
   a) Mountain ridge
   b) Mountain slope
   c) Breakland
3) Continental glaciated erosional lands
   a) Continental glacial ridge and slope
4) Continental glaciated depositional lands
   a) High terrace
   b) Floodplain and alluvium

Landtypes, a subset of landtype associations, were mapped by the Kootenai and Lolo National Forests. More

detailed mapping of soil types was conducted by the Natural Resource Conservation Service (NRCS) for private lands in the basin.

The **valley-bottom landtype** associated with streams was further divided into **valley-bottom types**, which generally correlate with subsections. Valley-bottom **habitat types** were also mapped. Vegetation response units, which are similar to habitat type and landtype association, were also identified.

Conclusion and Implications

A Geographical Information System (GIS) was used to compile the land classification on map layers, plot maps, and create map data summaries. Maps, descriptions, and data summaries are provided in this technical report for each hierarchical level.

Ecological classification is a tool to organize landscapes into areas with distinctive ecological potential. In the Thompson River Basin, results of the classification are being used to group upland and riverine/riparian habitats, assess the similarity of watersheds, screen for landscape hazards, and provide a foundation for more intensive watershed analysis.

Technical Report #11

Thompson Watershed Analyses: Beatrice Creek, Boiling Springs Creek, Murr Creek

Overview

In May 1997, Plum Creek Timber Company, L.P., initiated a watershed analysis in three tributaries to the Thompson River in western Montana: Beatrice Creek, Boiling Springs Creek, and Murr Creek. Watershed analysis is a process to address the cumulative effects of forest practices on two areas of public resources: fish habitat and water quality. The potential and existing resource conditions are described in the report, as are the relevant physical processes that affect the resource condition. The purpose of this report is to present results of the resource assessment and provide documentation and justification for identifying sensitive areas.

Key Points

Watershed analysis is conducted by studying separate **modules.** The modules studied in this Technical Report include the following:

- Mass wasting
- Surface erosion
- Hydrology
- Riparian function
- Channel condition
- Fish habitat

Once the analysts had worked through the modules, the information was brought together with the data from other modules to develop a more complete picture of the watersheds.

Supporting Technical Information

Plum Creek owns 52.4 percent of the analysis watersheds. The Forest Service manages 43.8 percent of the analysis area and the State of Montana manages 3.7 percent. Private lands comprise only 30 acres of the total analysis area, entirely within the Murr Creek watershed. The dominant land use in these watersheds is forestry. A secondary use is cattle grazing. In addition, all three watersheds are used by the public for recreation, primarily hunting and firewood cutting. This section summarizes the findings of the watershed analysis in each of the subject modules.

Mass Wasting. Landslides and other mass wasting features are rare. In the 50 square mile analysis area, only five modern-era mass wasting sites were identified. Four of these related to forest management and were caused by (1) steep road cutslopes with groundwater seeps, (2) poorly drained roads, and (3) poorly constructed road fills with groundwater seeps. However, none of these landslides delivered sediment to streams. Because of the relatively gentle slopes in the analysis watersheds, standard Best Management Practices (BMPs) minimize mass wasting.

Surface Erosion. Surface erosion from hillslopes and roads occurs when soil is exposed to surface water flow. Although there are local areas of soil disturbance on recently harvested hillslopes, field results show that BMPs prevented sediment delivery to streams. The road erosion

assessment compared sediment delivery from roads to natural background sediment. Roads in Beatrice and Boiling Springs Creek watersheds contribute more than 50 percent of the background erosion rate, and road erosion in Murr Creek contributes less than 50 percent. Most of the sediment delivered to streams occurs at key points along roads. For example, in Boiling Springs the top nine contributing locations deliver 76 percent of the road sediment volume. Sediment delivery may be reduced by adding drainage at stream crossings.

Hydrology. This module evaluated how streamflows have been altered by timber harvest. Because current forest vegetation is similar to the vegetation pattern in which the streams evolved, peak streamflows were modelled to be within 10 percent of background.

Riparian Function. This module evaluated the condition of riparian areas based on their ability to supply large woody debris (LWD) to stream channels and provide shade to maintain stream temperatures. More than 79 percent of riparian areas in the three study watersheds have a moderate-to-high potential for adding LWD to streams. Also, canopy cover of the stream channel network is generally sufficient to keep stream temperature below 15^{o}C.

Channel Condition. Stream channel gradient (slope, or steepness) is a major predictor of the shape, depth, and flow of the channel, which in turn predicts habitat potential. In the three watersheds analyzed, 14 percent of the stream segments have low stream gradients (less than 4 percent), while the remaining 86 percent have high stream gradients (greater than 4 percent). Actual and potential fish habitat is significantly greater in the low gradient group compared to the high gradient group. Lower-gradient stream segments tend to be more sensitive to watershed disturbance, with some exceptions.

Fish Habitat. Goals of the fish habitat module are to document existing and historic fish distribution, assess current habitat conditions, identify important habitat, and identify impacts to habitat from land management. Trout and char species in the analysis area include brook, bull, cutthroat, and rainbow trout. Brook and rainbow trout are non-native species, which were stocked as early as the 1930s. Although natural barriers to fish passage are present, no man-made barriers to fish movement were found in the analysis area. Fish habitat conditions varied from poor to good in the analysis watersheds and were largely a function of channel type.

Conclusion and Implications

Stream channels are shaped by a number of variables that interact to create a unique stream. Some variables, such as the gradient, valley confinement, and drainage area of a stream, are relatively unchanged by human activities. Other variables, such as the amount of coarse and fine sediment, the amount of large wood in the stream channel, and the volume and timing of flood events, can be influenced by management activities. Gathering this information allows managers to develop management practices to minimize or prevent problems in sensitive areas.

Technical Report #12

Stream Temperature Considerations in the Development of Plum Creek's Native Fish Habitat Conservation Plan

Overview

Many scientific studies have proven that streamside timber harvest can increase stream temperatures. The primary reason is that harvest removes shading from the stream and sunlight reaches the surface of the water, warming the stream. Native salmonids, particularly bull trout, are sensitive to increases in stream temperature. The purpose of Technical Report #12 is to evaluate stream temperature features that must be considered in the development of Plum Creek's Native Fish Habitat Conservation Plan (NFHCP).

Key Points

Five key subjects were addressed in this report to form the basis of the NFHCP:

1. Review of temperature requirements of native fish in the Project Area, including bull trout
2. Review of winter conditions on trout in ice-covered streams
3. Discussion of the potential influence of small streams on water temperature in downstream fish-bearing waters
4. Results of a study of canopy cover before and after timber harvest along 10 streams in Montana and Idaho
5. Development of a predictive stream temperature model for western Montana and northern Idaho

Supporting Technical Information

Managing riparian areas requires a thorough understanding of what controls stream temperature in a riparian system and the temperature needs of the native fish. Results of the temperature study are summarized below.

Temperature Requirements of Native Fish

Adult bull trout rear and migrate within a wide range of temperatures (4 to 20.5°C). This range is similar to those observed during steelhead migration (less than 21°C). Bull trout spawning temperatures range from 4 to 12°C, which is similar to other fall-spawning salmonids in the Project Area. Incubation temperatures for chinook salmon, a fall spawner, range from 5 to 14.4°C. In comparison, incubation temperatures for bull trout range from 1 to 6°C. Juvenile bull trout can rear within a wide range of water temperatures (4 to 20.5°C); however, optimal temperatures appear to fall between 10 and 15°C. This optimal temperature range appears to be cooler and narrower than for other salmonids in the Project Area. For example, steelhead, rainbow trout, and chinook all have optimal temperatures that range from 10°C to well above 15°C. In general, preferred temperatures for native salmonids in the Project Area are similar to the optimal temperatures for bull trout.

Winter Conditions on Trout in Ice-Covered Streams

The behavior, habitat use, and survival of trout at cold temperatures in winter differs from that during warmer, ice-free periods. During the winter, trout occupy stream locations with low water velocities (less than 15cm/s) and extensive cover, including clean substrate, large woody debris, undercut banks, deep pools, beaver ponds, and side channels. These areas can be affected by improper timber harvest, which can reduce or damage stream pools and banks and limit the influx of large woody debris. Removing stream shade may also make streams colder during winter, thus possibly increasing ice formation in streams.

Influence of Small Streams on Fish-Bearing Waters

Small, non fish-bearing, perennial streams occupy a large part of the drainage network in the NFHCP Project Area. Research suggests these streams could influence summertime water temperatures in downstream fish-bearing reaches if they add more than 20 percent of the streamflow to the fish-bearing reach. Also, the temperature of these small streams can change significantly in 500 feet. As such, an effective management strategy for controlling temperatures in downstream fish-bearing waters would be to provide sufficient shading in the lower 500 feet of these streams before they enter a fish-bearing stream.

Canopy Cover Study

Canopy cover and riparian stand conditions for nine streams in western Montana and one stream in northern Idaho were examined before and after timber harvest in 1997. Canopy cover reduction after harvest ranged from 0 to 13 percent. Of the ten sites measured, four had statistically significant decreases in canopy cover. With these levels of canopy cover change, stream temperature changes are expected to be small (less than $1^{o}C$) based on the predictive model developed during this study.

Predictive Stream Temperature Model

Predictive models can be used to describe the range of current conditions in the Project Area, estimate maximum stream temperatures under natural (or potential) conditions, or develop and test hypotheses as part of research and adaptive management. The models developed predict maximum summer water temperatures as a function of canopy cover, elevation, and an index of climatic conditions.

Conclusion and Implications

Results of this technical report will be used as a basis for the conservation commitments in Plum Creek's NFHCP. Although stream temperature has been studied in Washington and Oregon for over 25 years, little research has been conducted in the northern Rocky Mountains. Areas of uncertainty, such as specific temperature requirements of bull trout, are currently being explored in laboratory studies. These uncertainties will be addressed through an adaptive management process developed as part of the NFHCP.

Technical Report #13

Adaptive Management: Concepts and Applications to Plum Creek's Native Fish Habitat Conservation Plan

Overview

Adaptive management is a challenging blend of rigorous science and practical management designed to provide the basis for "learning by doing." Adaptive management is used in the Plum Creek Native Fish Habitat Conservation Plan (NFHCP) to address areas of uncertainty and risk. Adaptive management can be used to address "leaps of faith" in the NFHCP where there is dependence on theoretical models and untested conservation measures. The objectives of Technical Report #13 are twofold:

1. Examine the concept and application of adaptive management

2. Propose research and monitoring projects that may help the practice of adaptive management in the NFHCP

The array of candidate projects described in this report represent the opinions of the authors in consultation with outside experts. The final suite of projects selected for the NFHCP will depend on further discussions with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service.

Key Points

To be effective, adaptive management projects must include three components:

1. Clear objectives and testable theories that relate back to plan components

2. Credible design and study methods

3. Plan for changing management direction in response to new information

Technical Report #13 describes 15 proposed adaptive management projects for the NFHCP. The projects differ in the level of complexity and certainty, but must meet certain selection criteria to be included in the NFHCP.

Supporting Technical Information

Two basic experimental designs have been employed in the development of NFHCP research and monitoring projects. The first is the **mesurative or observational approach**, when the primary interest is the current status of the population or environmental setting. This approach requires careful consideration of sample size, data collection and analysis. The second is the **manipulative or experimental approach** when the objective is to establish cause-effect relationships. This can be achieved with either a **Before-After-Control-Impact** design or **Analysis of Variance** design.

Project Complexity and Certainty

Adaptive management projects proposed for the NFHCP fall under three categories:

- Continuous improvement monitoring
- Experimental management
- Basic research projects

Six of the 15 proposed projects are considered **continuous improvement monitoring** (CIM) because they are low

risk but high return investments, and the data can be immediately used to adjust management activities. Many of these activities involve annual database updates and inspections. Examples of CIM projects include road condition inventories, NFHCP implementation monitoring, grazing lease monitoring, and biological monitoring of bull trout redds.

Another six projects are considered **experimental management** with more rigorous scientific design because of their importance or complexity. Examples of experimental management projects include evaluating the effectiveness of NFHCP mitigation measures in reducing instream fine sediment from roads, and maintaining maximum water temperatures near background levels. Others include a project to examine the effectiveness of NFHCP riparian buffers in maintaining natural levels of in-channel large woody debris and the success of riparian restoration projects. Long-term projects are also proposed to speed watershed analysis using riparian "superguilds" and grazing trend plots.

Three of the projects are **basic research**. These topics are more speculative in nature or require more investigation before substantive mitigation measures can be initiated. Projects described under this category include development of a technique to suppress brook trout, and evaluation of conifer thinning to accelerate riparian forest development. A third project is designed to validate the Forest Vegetation Simulation model and riparian forest growth and yield relationships.

Project Criteria

The 15 projects listed in Technical Report #13 are proposed for the NFHCP. Several criteria will help Plum Creek and FWS to determine which projects will be chosen for implementation. To be selected, the project must do the following:

- Improve the level of "certainty" in mitigation measures
- Address the Four C's of cold, clean, complex, and connected water
- Consider the magnitude or potential risk to the species
- Be cost-effective
- Relate to a major NFHCP item that has large costs or significant uncertainly
- Be credibly investigated with appropriate technology and design

The goal of these economic and technical criteria is to get the best results for fish from the research and monitoring investment.

Conclusion and Implications

By the nature of the HCP process, a dynamic tension exists between the need to change management based on valid new information and the "No Surprises" policy that limits landowner liability for committing more land and money beyond the HCP requirements. Adaptive management is funded by the HCP applicant, in this case Plum Creek, to develop effective management strategies that achieve the objectives of the HCP. The ultimate result of this process is a better understanding of ecosystem function and management based on scientific fact.

Plum Creek Timber Company White Paper

Livestock Grazing on Plum Creek Timber Company Land in the Native Fish Habitat Conservation Planning Area

Overview

Since the turn of the century, livestock grazing has been a traditional use of much of Plum Creek's land in the Native Fish Habitat Conservation Plan (NFHCP) Project Area. Improper livestock grazing can affect fish habitat and water quality. The purpose of this white paper is to discuss the following grazing issues:

- History of grazing in Project Area
- Current status of grazing on Plum Creek lands
- Present condition of riparian areas in grazing allotments
- Plum Creek's Grazing Best Management Practices (BMPs)

Key Points

The following key points are explained in this white paper:

- Livestock grazing occurs on about 45 percent of Plum Creek land in the NFHCP Project Area
- Until recently, grazing has not been managed to address water quality.
- In 1994, Plum Creek adopted a set of Grazing BMPs for Montana and Idaho.
- Although riparian conditions seem to be improving, little data exist to support that contention. Additional research and monitoring should be undertaken to verify trends.

Supporting Technical Information

Grazing presents unique environmental management and protection challenges when compared to forestry.

- Grazing is historically an annual occurrence, while timber harvest is periodic.
- Cattle graze to the stream edge unless the area is fenced or limited to cows because of topography, while timber harvest activities are controlled through use of protective buffers.

In 1991, Plum Creek adopted a set of Environmental Principles to govern resource management activities. One of these principles directs Plum Creek to employ BMPs on their lands for water quality and aquatic resource protection. Also in the early 1990s, the Montana Streamside Management Zone Act and Regulations mandated stream buffers for timber harvest, but not for cattle grazing. Plum Creek felt that grazing caused water quality impacts, and adopted their own set of Grazing BMPs in 1995 to address water quality concerns.

Current Status of Grazing

Plum Creek has 764,560 acres classified as available for livestock grazing (98 percent of which is in Montana). Of the available grazing area, 588,779 acres (77 percent) are currently leased to 106 leaseholders. The remaining 175,781 acres (23 percent) are currently vacant.

To better understand impacts to bull trout from management actions, Plum Creek scientists define two types of watershed. Tier I watersheds contain bull trout spawning and rearing streams, while Tier II watersheds contain migration and foraging streams. Twenty-eight out of 82 Tier I watersheds (34 percent) contain some amount of land suitable for grazing. Tier II basins with large amounts of land presently leased for grazing include the Blackfoot River, Middle Clark Fork, Middle Kootenai, and Upper Clark Fork River. These four basins contain 91 percent of the currently leased grazing lands. During summer 1998, approximately 5,375 cow-calf pairs grazed Plum Creek lands.

Active grazing leases include 21.3 miles of Tier I watersheds, 12 miles of Tier II watersheds, and 19.7 miles of key migratory rivers.

Present Condition of Riparian Areas

Based on existing Plum Creek information, between 25 percent and 50 percent of riparian areas in allotments exhibit water quality and riparian impacts from livestock grazing.

The Montana Bull Trout Restoration Team prepared a series of reports that describe the status of bull trout for 11 basins in western Montana. The team identified grazing as a high risk to bull trout in the Upper Clark Fork, Bitterroot, and Blackfoot River drainages. Grazing was identified as a locally significant threat in the Thompson, Stillwater, and Fisher River watersheds. The Washington Department of Fish and Wildlife has also identified grazing as a high risk to bull trout in the Ahtanum Creek watershed.

Plum Creek's Grazing BMPs

Plum Creek's Grazing BMPs have three major components:

1. A set of minimum environmental performance standards for Plum Creek property.
2. A requirement for each leaseholder to prepare an annual range management plan for the grazing season that describes how cattle will be managed to achieve the performance standards above.
3. A monitoring and adaptive management program. Monitoring involves a form and photographs. Adaptive management is an "end of year report" that describes what environmental strategies worked well during the grazing season and what did not.

The Grazing BMPs are consistent with the Prescribed Grazing BMP framework developed by the Montana Grazing Practices Work Group.

Conclusion and Implications

Based on discussions with foresters, lessees, and leaseholder BMP monitoring, riparian conditions have been put on a positive trajectory since the BMP program was initiated in 1994. However, few scientific data are available to support these observations and opinions. To obtain hard data on the effectiveness of Plum Creek's Grazing BMPs, the NFHCP adaptive management strategy could include establishment of a network of long-term riparian monitoring plots where conditions could be periodically inventoried.

Plum Creek Timber Company Higher and Better Use Lands and Implications for Native Fish Conservation

Overview

Higher and Better Use (HBU) lands are lands owned by Plum Creek that might have a higher value for a use other than timber harvest. HBU lands may be valuable for recreation or conservation.

Plum Creek has committed to arranging for the conservation of HBU lands. These commitments are included in the Plum Creek Native Fish Habitat Conservation Plan (NFHCP).

Key Points

The purpose of this white paper is as follows:

- Identify the lands classified as HBU
- List the sales completed to date
- Evaluate the impact these lands have on bull trout
- Outline approaches for mitigating potential adverse impacts

In 1993, Plum Creek reviewed lands in the Rocky Mountain Region ownership to identify potential HBU properties. Approximately 7 percent of the lands in this region were identified as HBU lands (110,000 acres in 34 study areas). All of the HBU lands are located in Montana.

Approximately two-thirds of the HBU areas are located in the Thompson River Basin and the Fisher River Basin. Additional lands may be identified as HBU in the future.

Supporting Technical Information

In 1996, Plum Creek initiated a program to sell or exchange HBU lands in the Rocky Mountain Region. As of January 1999, approximately 22,000 acres of land have been offered for sale and 19,150 acres have been sold. The following groups have purchased HBU lands:

- **Public:** 73 percent (13,940 acres) to Bureau of Land Management (BLM), Montana Fish, Wildlife, and Parks, and the U.S. Forest Service
- **Conservation Buyers:** 13 percent (2,438 acres)
- **Developers:** 10 percent (1,932 acres)
- **Adjacent Landowners:** 5 percent (840 acres)

The largest sale was to the Nature Conservancy for 11,730 acres, which will eventually be transferred to the BLM (included in public total). This sale includes 10 miles along the Blackfoot River. Plum Creek has several other pending projects to exchange or sell HBU land.

Bull Trout and HBU

Seventy percent (77,000 acres) of the HBU lands are located within watersheds important to bull trout. Of these lands, 92 percent are located within the Thompson and Fisher River Basins.

The HBU land that is most important for bull trout is within river floodplains. HBU lands border an estimated 74 miles of streams designated as "key migratory rivers" for bull trout in the NFHCP.

Existing Regulations in Montana

Several state and county regulations apply to the sale, exchange, and use of property. These laws must be followed as Plum Creek seeks buyers for HBU land. The applicable laws are listed in detail for the HBU lands identified in this white paper.

Threats to Bull Trout

Scientists have identified several threats to bull trout. In response, various state and local regulations provide significant conservation for riparian areas. However, some concerns about impacts to bull trout on HBU lands are not directly addressed. These concerns include the following:

- How many trees and how much natural vegetation to leave around the floodplain
- Standards for road location and construction
- Controls for use of toxic materials such as pesticides and insecticides
- Control of animal waste
- Standards to limit impervious surface areas
- Control of private pond development

These concerns are addressed by conservation measures developed by Plum Creek.

Conclusion and Implications

Plum Creek committed to three conservation measures in the Land Use Planning section of the NFCHP:

- Land Use Principles
- Conservation Buyers
- Land Use Plan

Plum Creek adopted the **Land Use Principles** in 1995. These principles guide the planning, sale, and exchange of HBU lands. Plum Creek often seeks **Conservation Buyers** for HBU land, and has developed working relationships with conservation groups. Finally, Plum Creek has prepared a **Land Use Plan** for lands in key bull trout migratory corridors. The plan focuses on potential impacts within the floodplain, and addresses requirements for each of the concerns listed in the *Threats to Bull Trout* section of this summary.

Plum Creek Timber Company White Paper

Thompson River Riparian Reconnaissance and Monitoring

Overview

The riparian area along the Thompson River in northwest Montana has been impacted by a variety of legacy land use activities over the past 100 years. These have included riparian shrub and willow clearing to create hay meadows, livestock grazing, timber harvest, and road construction. In 1993, Plum Creek acquired many of these lands from Champion International. Plum Creek contracted with Riparian Resources, Inc., to assess conditions along 4 miles of the Upper Thompson River and recommend options for vegetative restoration. This report will be used to make decisions about what riparian restoration projects are necessary. In 1998, 1/4 mile of the most severely impacted riparian area was treated based on this report. This approach will be used as a template for how other impacted Key Migratory Rivers are assessed and treated as part of the NFHCP.

Key Points

The purpose of this white paper is to present the Upper Thompson River riparian reconnaissance and monitoring. The paper accomplishes the following:

- Describes the riparian assessment methods
- Records the results of monitoring
- Predicts future riparian vegetation changes
- Recommends methods for restoring impacted riparian areas

Supporting Technical Information

To evaluate the impacts of past activities and propose reclamation, scientists established a baseline for the Thompson River riparian area and evaluated past practices. This section describes the methods and results of the study.

Riparian Monitoring Methods

The project area was divided into eight polygons. The following data were recorded for each polygon:

- Dominant vegetation type
- Other common plant species
- Noxious weeds
- Riparian zone width
- Physical stream type (geomorphology)
- Comments

The polygons and dominant features were tied to GPS locations and mapped. The maps were also compared to aerial photos taken in 1935, 1955, 1969, and 1992.

Monitoring Results

The project area is dominated by a few shrub and grass (graminoid) types. Tree types were uncommon in the riparian area. The most common woody plant type was the succulent hawthorn (*Crataegus succulenta*). This plant community type may be **disturbance induced**. Long-term disturbances to native shrubs, such as willow, occurred as a result of livestock use or removal by humans. Once these native plants were gone, plants like the succulent hawthorn occupied a larger area.

The mountain alder (*Alnus incana*) community type is also common within the project area and is thought to increase with disturbance.

The next two most common shrub types, the Drummond willow/beaked sedge (*Salix drummondiana/Carex rostrata*) habitat type and the Geyer willow/beaked sedge (*Salix geyeriana/Carex rostrata*) habitat type, are less common now than historically. In the past, these shrubs were removed from the project area to convert the valley bottoms to hayfields and for other agricultural uses.

The most common grass is a cultivated species of reed canarygrass (*Phalaris arundinacea*), which was a major part of the hayfield grasses planted in the project area during the past 50 years. This plant dominates large areas of six polygons, and grows aggressively in dense, tall stands that essentially hold no other plants.

In addition to the vegetation survey, a cross-section of the stream was completed for each polygon. By evaluating the cross-sections, scientists determined whether the stream was functioning properly, or if stream function was at risk because of past disturbances. Of the eight polygons, four were functioning properly (single channel with established banks) and four were functional-at risk channels (unstable banks and stream braiding).

Projected Vegetation Changes

Based on the vegetation data collected, the shrub types may change to willow or possibly conifer plant types over time. However, the aggressive reed canarygrass may prevent significant vegetation change in areas where it currently dominates. Even with disturbance, this plant re-establishes itself quickly. In fact, it will probably continue to invade other moist areas in the riparian zone.

Reclamation Methods

The goal of reclamation is to speed the recovery of natural shrub species and decrease the grass species. Two approaches could be used:

- Hand-remove small areas of reed canarygrass and other hayfield grasses and plant shrubs, such as willow
- Mechanically remove large areas of reed canarygrass and plant willow

Banks along the main channel and overflow channels are good sites for hand removal of reed canarygrass and planting shrubs. Because of the invasive nature of the hayfield grasses, it may be necessary to go back and remove grasses again as the shrubs are becoming established.

Many locations are available for mechanically removing large sections of the grasses and planting shrubs by hand. However, Plum Creek should evaluate the success of the hand-planting efforts before attempting large plots.

Rebuilding parts of the river channel is probably not needed. As grazing is limited, the channel will likely recover by itself.

Conclusion and Implications

Based on this reconnaissance and monitoring, the Thompson River channel is likely to recover from past impacts. However, the riparian vegetation surrounding the channel may need help and reclamation measures to re-establish the natural shrub community.

Plum Creek Timber Company

Grazing Best Management Practices

Overview

This document outlines Plum Creek's Grazing Best Management Practices (BMPs), which set policies to conduct grazing in an environmentally sensitive manner. The grazing BMPs are intended to fulfill obligations under the federal Clean Water Act. They are also a part of Plum Creek's Native Fish Habitat Conservation Plan (NFHCP) that is being developed under the federal Endangered Species Act.

To develop these grazing BMPs, Plum Creek relied on input from individuals in the following organizations:

- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Plum Creek grazing leaseholders
- Montana Stockgrower's Association
- Natural Resource Conservation Service
- University of Montana Riparian Wetland Research Program

Key Points

Key components of Plum Creek's Grazing BMPs are as follows:

- Performance Standards
- Range Management Planning
- Monitoring
- End of Year Reporting

Supporting Technical Information

The grazing BMPs are set up to continuously feed new information into the land management process, and adjust management and policy as needed. First, minimum environmental **performance standards** are set for Plum Creek property. Then, grazing leaseholders must develop annual **range management plans (RMPs)** that describe the management system to be used to achieve, or lead to attainment, of the performance standards. Next, **monitoring** is conducted of riparian conditions at several sensitive locations to measure progress. Finally, an **end of year report** is developed by the leaseholder that describes which environmental measures worked well and which measures require modification in the next year to improve environmental conditions.

Performance Standards

Performance standards are intended to provide a measuring stick for environmental compliance. These standards are summarized briefly below:

- **Streambank stability:** Disturb no more than 10 percent of streambanks.
- **Riparian compaction:** Affect less than 10 percent of riparian soils.
- **Shrub utilization:** Use no more than 25 percent of current year's growth.
- **Tree regeneration:** Damage to less than 10 percent of seedlings and trees.
- **Visual/Appearance:** Subjective measure by lease administrator.
- **Shrub regeneration:** All age classes must be present in riparian areas.

- **Grass utilization:** Riparian grasses used to no less than 8 inches high; upland grasses no less than 4 inches.

- **Weeds:** No standard—note presence and species.

In addition to the performance standards, leaseholders are required to get an RMP approved prior to livestock turnout, include provisions for improvement of conditions over time in the RMP, monitor riparian conditions, and complete an end of the year report.

Range Management Planning

An RMP is a written record of the leaseholder's grazing goals and objectives, their plan of action to achieve the goals and objectives, and some form of measurement to determine if the leaseholder is successful. The RMP is a plan of action for the current year, and becomes a tool for future decision making and RMP adjustments. The grazing BMPs provide a sample outline for an RMP.

A toolbox of individual BMPs is provided to include in the RMP. Some of these BMPs are mandatory and some are optional. This system allows leaseholders to apply site-specific BMPs for their situation. In the list below, required BMPs are shown in italics:

- *Proper use and location of salt*
- Watering improvements
- *Fence construction and maintenance*
- *Appropriate season of use*
- Rotated pastures
- Riding (moving stock around)
- *Bulls on range*
- Armor watering holes on creeks
- *Proper number of animals*
- Yearling herds
- Rotating herds
- Upland wildlife considerations
- Vegetation rehabilitation
- Management at stream crossings
- Use vegetation to restrict movement
- Weed control
- Other BMPs identified by leaseholder

Monitoring

Monitoring involves a simple form and photo-points that are submitted to Plum Creek by the leaseholder. Environmental conditions must be monitored at several locations at least twice yearly. Monitoring lots should be located in environmentally sensitive areas and agreed to by Plum Creek's lease administrator.

End of Year Reporting

The leaseholder must prepare an end of year report that identifies the degree of environmental compliance, describes what worked well, and suggests modifications for the next year. If adequate progress is not made in attaining the performance standards or improving conditions over time, Plum Creek may require specific practices or may terminate the lease.

Conclusion and Implications

Plum Creek believes that forestry and livestock grazing are legitimate land uses, and, if conducted in a manner consistent with good stewardship of the land, are fully compatible with maintaining high-quality water and fisheries. The monitoring component of the grazing BMPs, and adaptive management research on BMP effectiveness, will help to assure that Plum Creek's environmental stewardship goals are met.