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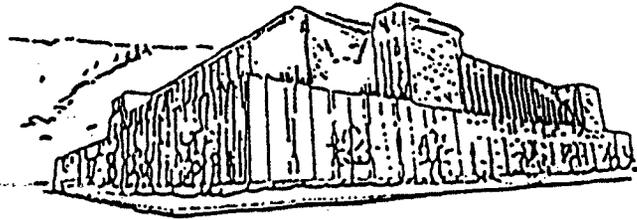
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**Riparian and Aquatic Habitat Monitoring on the
Kootenai National Forest
Critique for the 1997 Forest Plan Revisions**

**by
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presented in partial fulfillment of the requirements

for the degree of Masters of Science

in Environmental Studies

The University of Montana

1997

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Dean, Graduate School

8-7-97

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Riparian and Aquatic Habitat Monitoring on the Kootenai National Forest: Critique for the 1997 Forest Plan Revisions (174 pp.)

Director: Dr. Vicki Watson *VW*

The Kootenai National Forest adopted its first Forest Plan in 1987 with substantial provisions for water quality and riparian habitat monitoring. In the fall of 1997, the KNF begins a ten-year Forest Plan Revision under a directive from the Forest Service Washington, D.C. Office made in response to an appeal against the original 1987 Forest Plan by the Cabinet Resource Group and the Montana Wilderness Association filed in December of 1987. In the intervening years between 1987 and 1997, the Kootenai National Forest implemented a riparian and aquatic habitat monitoring program that only partially fulfilled the management goals and monitoring objectives of the Forest Plan. No critical non-agency assessment of that monitoring program exists. Because the National Forest Management Act (1976) directs all National Forests to revise their Forest Plans at least every fifteen years, the need exists to discuss riparian monitoring from a scientific standpoint from the onset of the Forest Plan Revision process.

This report analyzes the Kootenai National Forest Plan monitoring progress, describing its design and implementation problems and suggesting changes for the upcoming revisions. It concludes that management monitoring objectives were not met during the first ten years and that little progress has been made towards developing an effective strategic monitoring program to protect beneficial uses in riparian areas. Chief problems discussed are lack of strategic purpose, unfocused collection and recording of field data, and inability to validate models that were supposed to guarantee nondegradation. Case studies are provided concerning issues related to selected Forest Plan monitoring items, illustrating public input as a key element in successful monitoring, and critiquing data collection methods and GIS analysis. The conclusion supports a return to more qualitative monitoring practices and an increase in reporting and analysis frequency in a process more open to peer and public review.

Preface

The National Environmental Policy Act (NEPA) and the establishment of National Forest Plans in the late 1980s opened unprecedented forums for the public and public interest organizations to affect federal land management decisions. Relationships between the Forest Service and non-governmental environmental groups involved in timber management oversight activities have been stressful to both sides during the past ten years. I have been an active participant in the struggle to affect timber policies on the Kootenai National Forest as a member of a local organization known as the Cabinet Resource Group (CRG). I herein present this paper in due respect for the work by individuals on both sides of the table and hope that my experience during the last ten years can provide insight and assistance for watershed planning for the coming ten year cycle.

While it is in vogue to support reconciliation in natural resource management issues, I do not expect nor want controversy to disappear. Environmentalists have pursued a rational, scientific approach to forest resources in recent years but still lack an appropriate seat at the decision-making table. I do not believe that the time has come to give in to the "compromise mentality." As Appendix 2 illustrates, it has taken years of hard work to reach a position with "standing" in natural resource debates, and environmentalists should not relax their pressure until the Forest Service adequately addresses our key ecological concerns.

It is time to elevate the role of science in management debates in an effort to reach out to the many fine agency scientists who also wish to see field investigations improved. This

report is written with the hope that both sides can see common ground in its scientific criticisms and that from it and others like it, that there may come an opportunity to change the mandate of the Forest Service from resource extraction to resource conservation. I make frank criticisms of the work of many of the KNF's hydrologists, most of whom I consider personal friends and for whom I have enormous respect. I want to thank them for their assistance in compiling the data used in this report and hope that they can see that my intentions, even as an outside environmentalist, are positive. They will be responsible for encouraging changes from within and it is for their use that I have added detailed appendices concerning mistakes and technical problems discovered during my study.

I want to thank the Patagonia Foundation and the Norcross Wildlife Foundation for their support in this project. Without them, this independent analysis of the KNF monitoring program could not have been as technical nor as valid. I also want to thank CRG and its support for locally-based criticisms of management policies. Too few people have CRG's courage to oppose policies when the conflicts become as tense as we have seen over the past ten years. I would like to thank my committee for taking the time during summer to help me complete this project in a timely manner. Vicki Watson has been particularly helpful over the past year in focusing my attention on positive suggestions for Forest Plan Revisions and guiding me towards a readable format open to a wider public. Finally, I wish to thank my wife Michele who has paid a heavy price for my environmental activism, both as a Forest Service employee and as a person who had to

sacrifice too many hikes while I plugged away at nearly endless and not always useful data entry and writing. Still, we continue in our hope that humans can learn to live in our natural environment in a way that protects its precious habitat and native inhabitants.

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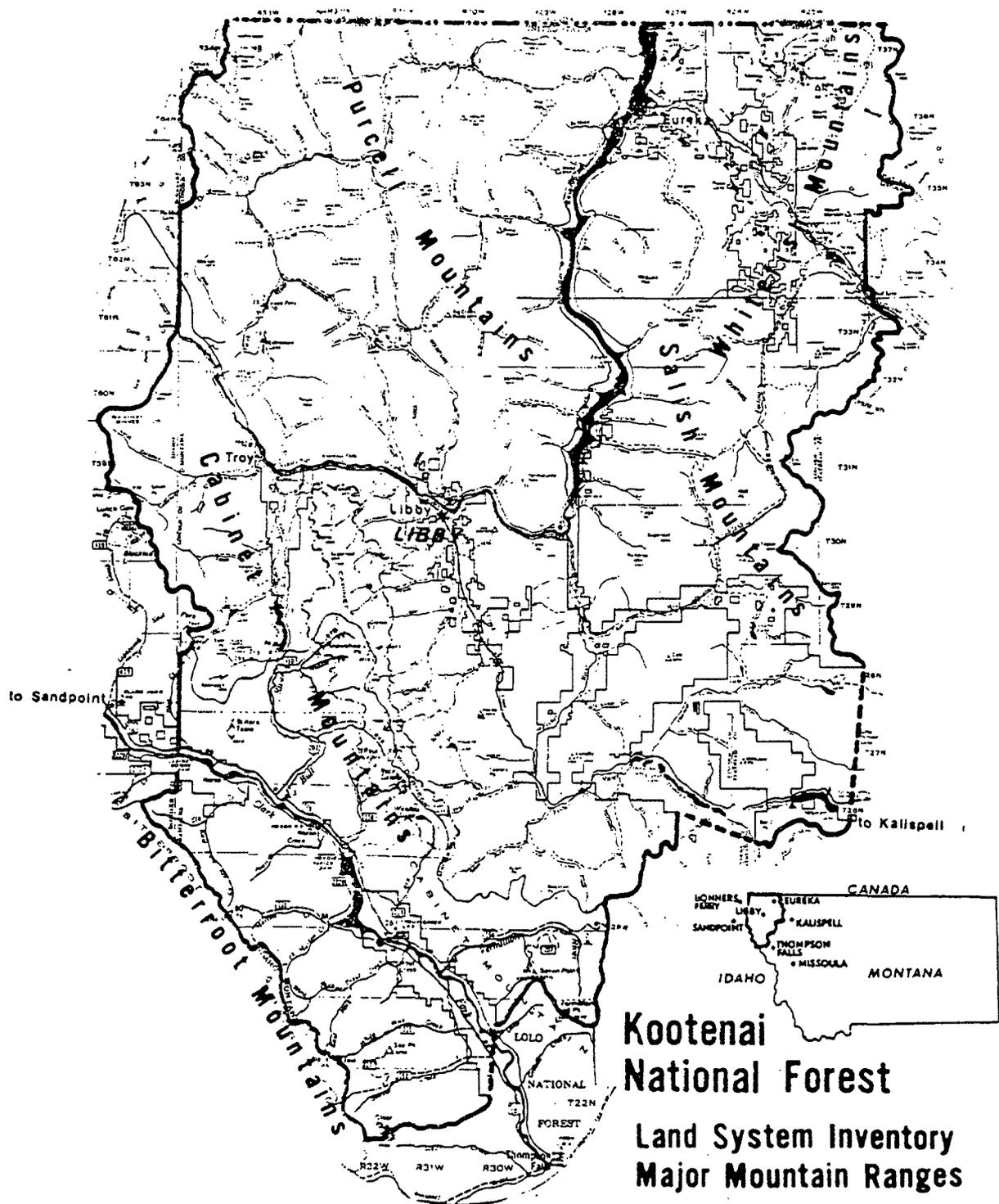
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Map 1 Kootenai National Forest



Riparian and Aquatic Habitat Monitoring on the

Kootenai National Forest

Critique for the 1997 Forest Plan Revisions

by Charles Clark

The National Forest Management Act (NFMA 1976) directed the Forest Service to prepare National Forest Land and Resource Management Plans (known as Forest Plans) to guide management decision-making by establishing guidelines and standards for individual projects and by developing monitoring programs to induce feedback responses for adaptive management policies. A successful appeal of the original Kootenai National Forest Forest Plan on the part of two Montana environmental organizations, the Cabinet Resource Group and the Montana Wilderness Association (CRG and MWA 1987), led the Kootenai National Forest (KNF) to announce in November, 1996, plans to begin a revision process for the KNF 1987 Forest Plan (KNF 1987). Similar revisions on other National Forests will soon follow under the NFMA provision of periodic revision at least every 15 years. This paper addresses the issues of water quality and riparian habitat monitoring in the context of the previous ten years of practices on the Kootenai National Forest in order to assist CRG and other environmental organizations in the preparation of effective public input for the up-coming Forest Plan Revision process.

The National Forest Management Act and the National Environmental Policy Act promote public input as a means to assist federal agencies in addressing public goals for forest and riparian protection. In the past, acceptable riparian management was defined in

terms of the protection of human beneficial uses of aquatic resources, including drinking water (US Clean Water Act 1972) and the maintenance and improvement of fisheries (Montana Water Quality Act 1984). Under these guidelines, the state of Montana established safe levels for toxic chemicals and sedimentation criteria to protect fish habitat. With time, legal limits on sedimentation were dropped in favor of the implementation of Best Management Practices (BMP) and subsequent BMP effectiveness monitoring in an effort to prevent undesired sedimentation before it occurred (BMP Notification Law 1990). More recently, public concerns over the health of riparian habitats (Manning 1991; PAC 1995) led to stricter regulations over timber harvests in streamside management zones (MCA 77-5-302) and the establishment of watershed and ecosystem planning (REIC 1995; Quigley et al. 1996). Because aquatic and riparian ecosystems are nested within larger forest ecosystems (Noss 1989; Hammond 1992), the scope and scale of analyzing and monitoring riparian and aquatic habitat health remains open to debate. Between small reach restoration projects and the mammoth Upper Columbia River Basin Ecosystem Management Plan lie many levels of aquatic, riparian, and watershed decision-making. The public participates primarily in three - the Interior Columbia Basin Ecosystem Management Project (ICBEMP) (289,217 square miles), the Forest Plan EIS (KNF - 4860 square miles), and site specific projects on the national forest district level (environmental assessments, 10-100 square miles).

A watershed is an area of land which drains to a common point. Within a watershed are areas of riparian habitat, defined as areas near the land-water interface in which an interdependent biological community and physical habitat interact in processes which are

necessary for the direct maintenance of healthy aquatic life and habitat. Riparian habitat includes aquatic inhabitants (fish, macroinvertebrates, instream plant life) and physical components (pools and riffles, stream channels), streamside and wetsite plant communities (e.g. oak fern, skunk cabbage, willows, and dogwood), and forest habitat that, by its nature of being near aquatic habitat, provides special riparian components (large woody debris and litter) and processes (shading and sediment trapping). Disturbance to an aquatic system implies changes induced from the outside, either by natural events (such as floods caused by rain-on-snow melting events) or by elevated water yields and increased sedimentation caused by timber harvest. Disturbance to an aquatic ecosystem in equilibrium can be of short duration (a pulse disturbance) or of long-term duration (a chronic disturbance), but in either case it is expected that the aquatic system will eventually return either to a similar equilibrium state (recovery) or to a new equilibrium state (Yount and Niemi 1990). If that new state is more simplified and provides fewer biological niches, reduces the number of surviving riparian-dependent species, or reduces aquatic and wetsite populations, it is considered *degraded* even if it has reached a new equilibrium state.

Degradation in KNF watersheds is evidenced by the findings in List 1.

Degradation Indicators on the KNF

1) 41% of KNF watersheds are acknowledged to have reached watershed condition limits or surpassed them based on an assessment of projected water yield and sediment increases from clearcutting and high road densities (KNF 1993a:9).

2) 24% of all watersheds, including mixed ownership watersheds, are beyond allowable peak flow water yield increase limits set by WATSED models used to determine timber harvest levels (KNF 1997:74).

3) Research indicates that channel stability begins to weaken at flow levels substantially below Forest Plan peak flow limits (MacDonald et al. 1997:180).

4) The Forest Service failed to meet any of its nine Forest Plan riparian monitoring criteria that should produce feedback and changes in practice or policy (see Appendix 1).

5) BMP risk factors are higher than guideline limits, particularly when measured by the state during BMP field audits (KNF 1993a; KNF 1997; Appendix 1).

6) Site specific monitoring continues to show persistent degradation from smaller projects, even when BMPs are adequately administered (KNF 1996a; KNF 1996b).

7) According to comparative research with other western forests, WATSED and Forest Plan models which allow peak flow increases over 14% may be set at the upper end of natural peak flow probabilities, leaving little margin of error (MacDonald et al. 1997:21).

8) Extensive historical two-sided and one-sided riparian clearcuts have a chronic effect on stream and riparian structure, particularly in the slow recovery and recruitment of large woody debris, indicating a need for emphasizing riparian restoration (Bojonell 1993).

9) Bank cutting and mass wasting have accelerated in streams and stream channels with the onset of wetter climatic conditions in the 1990s but have not been systematically recorded and tracked (personal observation).

Both the public and federal agencies agree that one purpose of monitoring riparian and aquatic habitat is to determine at what levels human activity introduces degradation, be it short-term or long-term, into an aquatic system. A well-designed monitoring program¹ should instigate management feedback loops to change policies and practices to better

protect beneficial uses and riparian resources. With the publication of the ICBEMP scientific findings, ecosystem health became a key management objective. The public has an additional monitoring concern not addressed by federal agencies - prevention of what environmental sociologists call *bureaucratic slippage*. Bureaucratic slippage is the progressive weakening of environmental laws through inadequate implementation of internal regulations. These often fall prey to budgetary constraints and the influence of a specific clientele, e.g. the timber industry (Freudenburg and Gramling 1992). Outside the agency, monitoring is seen as a tool with which to judge agency integrity and to enforce compliance with environmental legislation. The Kootenai National Forest is completing its tenth year of operation under the 1987 KNF Forest Plan which included nine items related to riparian habitat maintenance. What are the results of its riparian monitoring program? Has the monitoring program been sufficient to protect the public's beneficial uses of aquatic resources and riparian habitat? What changes have occurred in the monitoring program since its inception and what mistakes have been made? This report addresses these questions by analyzing Forest Service yearly and site specific self-evaluation reports, by introducing research and ICBEMP scientific papers, and by introducing the results of my own investigation into KNF procedures during the past ten years. Finally, it recommends specific policy changes to be made in the KNF's water quality monitoring for inclusion in the upcoming KNF Forest Plan Revisions.

Analysis of the KNF 1987-1996 Riparian and Aquatic Habitat Monitoring

The Kootenai National Forest organized three monitoring levels: (1) the Forest Plan monitoring of seven permanent stations for validation of models used to estimate water

and sediment yield responses to timber harvest; (2) project monitoring of instream conditions and BMPs; and (3) a handful of analytical scientific research projects. As will be seen, in spite of the collection of boxes of data and reports, the lack of technical capabilities and funding limitations precluded model validation and few conclusions arose from the monitoring concerning the links between timber harvest and channel instability in the last ten years.

Several types of monitoring exist on the KNF, some monitoring management activity and some monitoring aquatic conditions. Implementation monitoring evaluates whether actions called for in the Forest Plan, including monitoring, occurred when they should have. Effectiveness monitoring evaluates the question, "When monitoring occurred, was it effective in measuring trends in management policy and instream conditions?" Best Management Practices (BMP)² monitoring specifically asks if, when BMPs were implemented, did they limit potential sediment flows into creeks? Since BMP failure introduces a risk factor to aquatic health, combining implementation and effectiveness monitoring of BMPs is a form of management risk assessment directly related to in-forest harvest practices. Finally, validation monitoring provides data to validate models that predict the effect of management actions. Validation monitoring requires analytical methods, technical training, honest evaluation and peer review and should be open to public scrutiny.

Strategic planning designs effective monitoring to guide management policy changes. An effective monitoring program preselects meaningful items to be measured, includes all relevant data sources, and lists its expected precision and reliability. It should establish a

time frame and frequency for measurements, report results following a pre-arranged time-table, and establish acceptable limits of variability beyond which policy feedback loops would be induced. Feedback loops, in turn, change management practices or redesign the monitoring program depending on how best to protect resources and beneficial uses.

The objective of project monitoring is to understand degradation from a given event (event monitoring) or to reveal the response of aquatic processes over the long-run (trend monitoring). Due to the vagaries of management policy, budget constraints, legal manipulations, and personnel and technical skill availability, it is important to build a strategic watershed plan that utilizes event monitoring to build a trend database and to initiate feedback loops by monitoring variation in limit indicators at the project level. *The KNF Forest Plan did not differentiate between trend and event monitoring and thus did not organize project monitoring to initiate management policy feedback loops.* In place of a strategic monitoring plan, the KNF Forest Plan established seven base monitoring stations, mostly former USGS monitoring stations, under the assumption that these stations would validate the various models being used to detect degradation from timber harvest and roadbuilding. These sites, rather than being randomly chosen or purposively sampled to reflect the variability across harvesting sites and stream conditions, were chosen for convenience and the availability of previous records. Thus, while providing a form of trend monitoring for the given sites, they did not represent actual harvest effects nor were they matched to particular reference streams. The sites have yet to yield useful

information for either effectiveness or validation monitoring proposed under the Forest Plan (KNF 1997).

The 1987 Forest Plan selected nine monitoring items related to the health of aquatic and riparian ecosystems - old growth, snag habitat, indicator species, riparian habitat, fisheries habitat, soil and water conservation practices (BMPs), stream sedimentation, water yield increases, and soil productivity changes (compaction). Each item was accompanied by a set of "acceptable variation" standards (see Figure 1 and Appendix 1). However, the acceptable levels of variation for the items in the Forest Plan had no scientific justification and can be taken only as "best judgment" levels. Each item included criteria for the initiation of a feedback loop that would re-evaluate the item and its monitoring effectiveness. How feedback loops would bring about changes in management policies was left to agency discretion outside the realm of public scrutiny (KNF 1993b). Most timber management changes in the years of my observation came from pressure placed on the Forest Service by environmental organizations (see Appendix 2).

Event monitoring, specifically tying monitoring to a given timber sale, harvest practice, fire regime, or localized observed degradation has not been used for riparian trends analysis on the KNF. In 1993, a lawsuit by the former KNF supervisor led to a court decision which determined that K-V Funding, moneys gathered from a specific timber sale's receipts, could not be used for long-term monitoring or for monitoring outside the specific sale area. Thus, collection of funds from timber sales for water quality monitoring, other than while the sale is progressing, is illegal and most riparian monitoring financing must be received through separate funding requests from Congress. Since

Figure 1 Forest Plan Riparian Monitoring Standards and Frequency

Forest Plan Implementation Appendix C-1 of 1988-89 Monitoring Report

Goals of Monitoring and Evaluation

- How well the Forest is meeting its planned goals and objectives
- If existing and emerging public issues and management concerns are being adequately addressed
- How closely the Forest Plan's management standards are being followed
- If the effects of implementing the Forest Plan are occurring as predicted
- If implementing the Forest Plan is affecting the land, resources, and communities adjacent to or near the Forest
- If research is needed to support the management of the Forest, beyond those identified in the Forest Plan
- If there is a need to amend or revise the Forest Plan

C-9 Riparian Habitat

Effect to be measured - Riparian Habitat Condition (1992 - Ensure that the intent of riparian management goals is met

Reporting frequency - annually (1988-1992) (1992 once every five years)

Limits of variability - 1992 Failure to meet State standards; 1997 - failure to meet Inland Native Fish Strategy

C - 10 Fisheries Habitat

Effect to be measured - Redd, changes, particle size in sediment cores, temperature, embeddedness, woody debris

Reporting frequency - "Every 2 years (1989, '91, '93, '95, '97)"

Limits of variability - 1988 +/- 10% change in Redds (1997 - dropped)
 +/- 2 degrees change in stream temperature
 +/- 10% change in fine sediments (1997 - dropped)
 +/- 10% change in embeddedness
 +/- 20% change in debris accumulations

F-1 Soil and Water Conservation Practices

Effect to be measured - Determine if Regional and Project Soil and Water practices meet State Water Standards

Reporting frequency - annually (1988-1992)

Limits of Variability - Failure to meet State Standards (NTU = 5 mg/l)

F-2 Stream Sedimentation

Effect to be measured - Determine sediment impacts on fishery habitat, bedload, RSI, X-section, size

Reporting frequency - annually (1988-1992)

Limits of variability - 20% increase in bedload and suspended solids; 1997 unknown

F-3 Water Yield

Effect to be measured - Determine the cumulative level of water-yield increases and the effects on stream channels

Reporting frequency - annually (1988-1992)

Limits of variability - 20% increase in channel stability rating (never used)
 20% of watershed exceeds hydrologic guidelines

F-4 Soil Changes

Effects to be measured - soil compaction, surface displacement, site quality

Reporting frequency - every five years

Limits of variability - 15% decrease in productivity

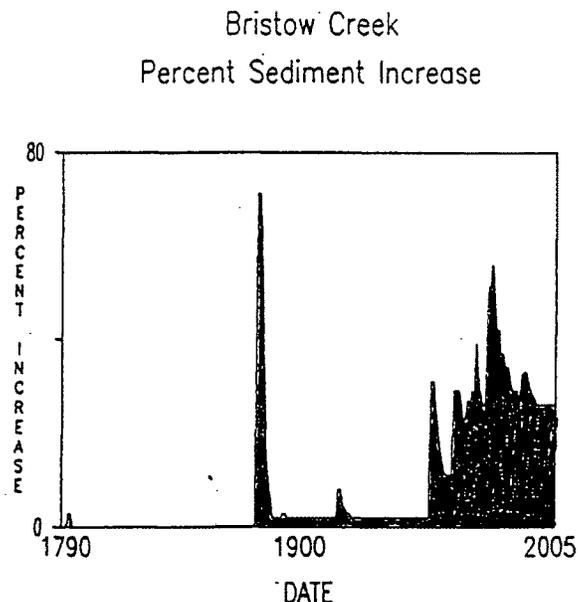
effects from timber harvest, peak flow increases, and sedimentation have a duration of 3-120 years (KNF 1987, 1993a, 1997; Yount and Niemi 1990; PRC 1994; Callahan 1996) direct timber sale receipts and monitoring efforts cannot be expected to assist trend monitoring unless they are carefully planned within the scope of a forest-wide strategy.

Sadly, the KNF Forest Plan had no over-riding monitoring strategy, and its monitoring program during the first ten years of Forest Panning has been ill-designed and haphazard at best. The ICBEMP scientific recommendations (see Appendix 3) support two strategies: 1) thorough fish population studies to prioritize watersheds for recovery and protection and 2) intensive instream inventories after major disturbance events. However, the former are not directly tied to timber harvests, and the latter emphasize peak watershed events that introduce rapid channel changes but do not address many chronic problems associated with timber harvest and fish habitat degradation. Habitat component mapping is a secondary monitoring objective under the ICBEMP.

The yearly Forest Plan Monitoring Reports reveal that the Forest Service did not meet any of its Forest Plan objectives for its nine riparian-related monitored items. A detailed analysis of the monitoring results and those from site specific monitoring projects is included in Appendix 1. The Forest Service identified lack of strategic monitoring, lack of reference and baseline data, high natural variability, and budget constraints as chief problems associated with its lack of monitoring success and failure to achieve Forest Plan objectives (KNF 1993a; KNF 1997). Concerns over cumulative watershed conditions led the Forest Service to institute a watershed condition assessment, modeled on the consideration of historic harvest levels, road densities, hydraulic models, and field

observations, that revealed that 12% of national forest lands exceeded peak flow limits and 29% more were at the hydraulic limits set by WATSED to estimate when channel instability might occur (KNF 1993a). Site specific monitoring revealed both additional problems and some successes - degraded fish habitat was common in lodgepole salvage areas, man-caused burns and wildfires created excessive run-off and sedimentation, and mass wasting and channel bank cutting increased with high flows and rain-on-snow events in the 1990s. But Bristow Creek, a critical spawning habitat for the Koocanusa Reservoir, returned to a stable, though not recovered, channel condition (see Figure 2), and pool restoration efforts in Graves Creek were a success (Perkinson 1989).

Figure 2 Chronic Sedimentation Increase from Timber Harvest, Bristow Creek



Source: "Bristow Creek Water Resource Effects," Bristow Creek Ecosystem Management Project, Kootenai National Forest, Canoe Gulch District, 1996.

Public input into monitoring since 1987 remained minor. The Cabinet Resource Group and American Wildlands successfully appealed and then negotiated a monitoring program for the Swamp-Edna Timber Sale in 1989 (KNF 1990a) which then served as a model for the Upper Yaak FEIS (KNF 1990b) monitoring program a year later. Deteriorating relationships between environmentalists and the Forest Service in 1991, however, left monitoring as an in-house practice rather than a public one. The KNF's five year review of the monitoring program and its failures was exempted from public review (KNF 1993b). Project reports and analyses became public only through Freedom of Information Act Requests and litigation. The question as to whether monitoring failures established legal non-compliance is currently being decided in District Court (TEC 1996), but Forest Service arguments presented in court briefing papers clearly state the government's position that monitoring is discretionary and does not require formal public review (USDA FS 1997):

"Monitoring's purpose is to make 'a threshold determination' [whether] further inquiry is warranted." (pg. 2)

"The monitoring reports are not ends in themselves, but are used to evaluate whether changes in forest management are necessary." (pg. 8)

"The duty to conduct studies is only reviewable in the context of discrete, final decisions. ... [The plaintiff] must identify and contest specific final decisions involving the plan." (pg. 12)

What is clear at the moment is that the KNF monitoring program evolved through discretionary management decisions since its inception ten years ago. Monitored

variables, their indices and levels of validation, and the methodology for their measurement changed from year to year and site to site, leaving the Forest Service to inevitably conclude that its instream monitoring produced "inconclusive" results (KNF 1997). Monitoring reports and analyses from final decisions (i.e. specific projects) which are reviewable are conspicuously absent both in the annual Monitoring Reports and from materials requested through the Freedom of Information Act (see Table 1). The public has been limited to reading the Annual Monitoring Reports as their only means to analyze compliance with either the KNF Forest Plan or with site specific monitoring objectives.

Table 1 List of Freedom of Information Act Requests

Date	Costs	Information Requested
January 29, 1993		Three Rivers CSR forms
January 30, 1993	Reproduction - \$34.60	Three Rivers CSR maps and summaries
November 19, 1993	Reproduction - \$209 Search Time - \$480 Clerical \$160	Rexford District CSR forms and summaries
November 22, 1993		Three Rivers Updated Maps
October 9, 1996		Drainage Coverages, CFF Monitoring Stations locations
October 23, 1996	Reproduction - \$56.40	Maps and CSR forms, Canoe Gulch
April 14, 1997	Reproduction - \$72.40	MacDonald et al. 1997 study
April 15, 1997	Search time - \$350	1994, 1995 Monitoring Summaries

Critique of the Monitoring Program - What Went Wrong?

The KNF Forest Plan lacked an over-riding strategy capable of building an adequate database for long-term trend monitoring. The Forest Plan developed seven monitoring sites to evaluate timber harvest-riparian health relationships, but as early as 1990 realized

that poor site selection, inconsistent monitoring, and natural variability were making it impossible to assess harvest effects on aquatic habitat or to document the protection of instream beneficial uses (KNF 1992; KNF 1993a). Even when water yield modeling, used to determine allowable harvest levels, indicated non-compliance with Forest Plan Standards and when a watershed condition assessment revealed extensive riparian condition problems, no strategic plan was prepared. The Forest Service introduced 100 foot-wide Streamside Management Zones as Amendment 26 to the Forest Plan, but this width was questionably narrow as a KNF study in 1991 found most SMZs to be between 160 and 650 feet (Pfister et al. 1991). Shortly after adopting SMZ guidelines, the Forest Service was caught ignoring them in the field (see Swamp-Edna discussion in Appendix 2). They actually reduced SMZ widths in half in 1994 when the Montana legislature passed the Streamside Management Zone Law which set narrower SMZ widths. The KNF began to rely on BMP implementation and monitoring to fulfill its riparian instream monitoring objectives (KNF 1993a; KNF 1997). BMP implementation fulfills state regulations for the avoidance of degradation during harvests, but does not prove success in "maintaining and improving habitat" as required by the state's Water Quality Act (CRG and MWA 1987). Perhaps worse yet were the Annual Monitoring Report assessments of BMPs (KNF 1997) which reported BMP implementation and effectiveness as independent variables when their risks are, in fact, multiplicative. Risk from BMP failures was actually higher than established risk criteria in nearly all years in spite of KNF reports to the contrary (see Item F-1 in Appendix 1).

The lack of a strategic plan for database development and standardization led to an inconsistent instream monitoring program whose first ten year's of data will provide very little useful information for trend analysis. This is important because another 65,000 acres have been harvested on KNF lands in the meantime. Furthermore, while BMP monitoring replaced instream variable monitoring for fish habitat (Item C-10) and sedimentation (Item F-2) under agency discretionary changes, continuing instream monitoring switched its focus from monitoring harvest impacts on streams to stream channel classification and time consuming cross-section measurements. These changes themselves have been questioned by in-house research which casts doubt on the applicability of Rosgen classifications to the KNF streams (MacDonald et al. 1997) and by the KNF's rather strange assertion in its 1996 Annual Monitoring Report that the "lack of a computer model that can evaluate between-year changes" in stream channel morphology makes cross sectional analysis beyond agency capabilities. Actually, cross sectional program software is available from the EPA, over the Internet, and the Forest Service already uses its own R4 CROSS model (Bojonell 1993) for cross sectional computer analysis.

The issue of timber harvest effects on water yield increases and sedimentation, integral to validating the KNF Forest Plan Water Yield Guidelines and WATSED, their water and sediment yield model, was passed on to a series of independent scientific investigations: sediment trapping in first and second order streams (Bojonell 1993); validation of water yields (MacDonald and Hoffman 1995; MacDonald et al. 1997) and measuring post-fire water yield relationships to cut and uncut areas (Dodd 1995; Luce 1997). Their conclusions on the validity of KNF water and sediment yield modeling remains

"inconclusive." While scientific investigation is producing greater understanding of watershed processes on the KNF, how to measure timber harvest induced degradation remains elusive.

Perhaps the most glaring deficiency is that ten years of monitoring has produced virtually no summary reports or analyses concerning the data being collected. The Montana Water Quality Bureau complained of this as early as 1993 (Tralles 1993). Reports from detailed site specific monitoring programs, such as the Camp-Everett Monitoring Report due in 1991, would have helped the agency revise its program. To date, intermediate and annual reports from Swamp-Edna, the Upper Yaak, 4th of July, Big Creek Monitoring, Sunday Creek Monitoring, and Arbo Creek, among others, have never been produced, leaving the Forest Plan Monitoring Reports to make conclusions without supporting analysis. No wonder the KNF administration has reported "inconclusiveness" and relied on discretionary ambiguity rather than instream findings to produce its public summaries. Yet without project analyses of the vast effort to collect data throughout the KNF, it remains impossible for the lay public to assess the compliance, effectiveness and validity of KNF riparian monitoring.

Recommendations for a Revised Forest Plan Monitoring Program

The Kootenai National Forest Plan lacked a strategic plan to guide its monitoring program. A Strategic Watershed Plan would elucidate achievable monitoring objectives and better tie together project monitoring into a more analytical summary of forest-wide riparian conditions. Discretionary monitoring, optional at the whims of Forest Service

choice and budgeting, with its less-than scientific validation criteria has not proven its utility during the first ten years of monitoring. Discretion permitted in-house changes in methodology and evaluation criteria, allowing the Forest to monitor (or not to) at will without the benefit of public oversight or peer review and without having to produce summary analysis of individual monitoring projects. A Strategic Watershed Plan would outline a planned monitoring program, relate individual project monitoring to Forest Plan monitoring, set standards for analysis periods and summary reporting, and provide avenues for public input.

Under the Washington Office directive to revise the Kootenai National Forest Plan, the KNF has been ordered to keep its timber harvests below 150 mmbf/year. This represents a 19% reduction over historical output averages (Clark 1996), a third of the reduction or about 6.3% accounted for by streamside management zone protection imposed in 1989 (KNF 1997). The timber harvest reduction ordered by the Washington Office fails to adequately reflect potential degradation due to in-field activity levels beyond modeled safe water yield limits. According to the KNF Watershed Condition Assessment based on WATSED, 41% of national forest drainages are pushing their hydrological limits and 24% of all drainages (mixed and private) are past water yield levels. The Kootenai National Forest seems content to continue harvests at this level because monitoring results and feedback loops that might have restricted harvests were tied to sedimentation and fish habitat variables that often were not monitored or whose results remain "inconclusive." In fact, the government has stated that "hydrological and fisheries studies involve scientific methodologies that have inherent difficulties in obtaining conclusive results. ... [T]he

Forest has repeatedly attempted to adjust its monitoring to improve the quality of the results." (USDA FS 1997:32)

The Forest Service did modify its methodologies over the past decade, though not necessarily to the benefit of hydrological or riparian analysis. Scientific studies continually emphasize the need to establish reference data and stream reach baseline data (KNF 1993a; KNF 1997; MacDonald et al. 1997). When methodologies are modified, earlier data cannot be related with later data.

A focused strategy on monitoring issues should begin with the third step in the Inland Native Fish Strategy (INFISH) watershed assessment - defining current watershed conditions (see Appendix 3 for a detailed analysis of INFISH proposals). *Management issues should arise from an assessment of current conditions, not be devised before conditions are assessed and known.* The present KNF practice of developing management issues prior to concrete analysis, continued as INFISH step 2, encourages the premature commitment of resources to a proposed project rather than using a strategic watershed plan to guide project development. Instead, watershed analysis should evaluate watershed conditions and then develop projects that appropriately relate to improving those conditions. Field-based strategies would emphasize restoration projects over harvest projects in many cases, an idea first pushed by the Northern Rockies Ecosystem Protection Act by environmentalists (AWR 1991) and given broad support within INFISH watershed prioritization analysis³.

Current watershed condition analysis includes three investigation areas: types, components, and processes. *Types* refer to watershed and stream reach classifications.

They serve to standardize observations between monitored areas, assisting statistical inference capabilities during management decision-making. During the past ten years, the Forest changed its typing emphasis from KNF streamflow classification (large perennial; small perennial; intermittent and ephemeral; dry draws and swales; ponds and lakes) to stream channel classification (Rosgen reaches), and then to INFISH streamflow-fish classifications (fish-bearing; perennial without fish; ponds, lakes, reservoirs and wetlands; intermittent). The water yield validation study done by CSU (MacDonald et al. 1997) recommends that the KNF adopt a fourth flow-based classification system (colluvial step-pools, pool-riffle, and downstream pools) in order to track variables which statistically correlate to timber harvest effects on streams. Classification should continue as a separate and specific strategic goal in the revised Forest Plan.

Components refers to the current quantity, quality and condition of riparian components as descriptive features in riparian zones and classified stream reaches. This permits the analysis of what features are missing and degraded in a given riparian area. The Forest Plan tracks miles of two-sided riparian harvest and redd locations. INFISH adoption added pool frequency, water temperature, and large woody debris to the list of habitat indicators to be monitored. Riparian component variables should add riparian width, snag densities, wetsite plant community locations, shade estimates, and previous harvest activity to its reach database system. Aquatic components include fish presence, redd presence, and macroinvertebrate sampling. Taken together, these variables permit an ecosystem quality analysis of current conditions useful for the evaluation of riparian needs and management options.

Defining classes or conditions does not describe riparian *processes*. Ideally, infield and instream monitoring would compare reference reaches and streams to harvested areas in order to assess management effects on riparian ecosystem health. But several hundred thousand acres on the KNF have been harvested and 25,000 miles of roads already constructed (KNF 1987). Few "pristine" reference areas remain in lands suitable for timber harvest. Lack of reference data and wide ranges in climatic variation pose grave problems to instream process analysis on the KNF. Not only do adjacent drainages show great seasonal and climatic variations (MacDonald et al. 1997) but streams themselves show significant reach and channel differences along their mainstems (Bojonell 1993), making cross-referencing between watersheds and summation over adjacent reaches extremely difficult. This would be true even with standardized, programmed data which the Forest Service lacks because of its non-strategic monitoring during the last ten years. Monitoring failure for fish habitat and sedimentation led the KNF to suggest the following for Forest Plan Revisions:

"This change should include a rigorous sample design, identification of standard sampling methods, a detailed strategy for data stratification, data sharing with adjacent National Forests, a shared database for all monitoring results, a change in the temperature standard to conform to water quality regulations, explicit data evaluation methods that will be used to support a finding of unacceptable change, and several types of monitoring (implementation effects, trends, restoration effects, and reference conditions)." (KNF 1997:62)

Process monitoring includes BMP monitoring and instream variable monitoring of changing components that reveal sedimentation and flow effects on fish and macroinvertebrate viability. Among those are changes in channel cross sections, embeddedness, pool particle size distribution, redd core samples, peak flow, temperature, and fish and macroinvertebrate population studies. Qualitative inventory methodology also changed in the last ten years, as the Pfankuch (1978) Channel Stability Rating form was revised, its riparian feature page dropped, and the Riffle Stability Index (Kappesser 1992) added to monitoring procedures. CSRs and RSIs are used together to make quick project-oriented assessments of current reach and channel stability. As absolute measures of stream channel stability, neither have faced peer review from outside of the agency and CSRs remain inexact channel evaluations in that they may change considerably depending on the skill and experience of the investigator. However, these measures do have importance because they represent actual in-channel inventories by hydrology technicians and because historical use allows rough inferences of channel trends.

I concur with the MacDonald study in that Channel Stability Inventories should be adjusted to include measurement of length of cutbank per mile - one of two variables that significantly correlated to previous harvest in the study. The other variable, pool substrate material, should be incorporated into a project requirement for the measurement of pool structure and pool infilling (or clearing) rates. Pool structure and process have been emphasized by many of the scientific studies of the KNF during the last ten years - a study of pool restoration (Perkinson 1989), the study of water and sediment yields (MacDonald et al. 1997), and Bojonell's (1993) study of sediment trapping in first and second order

streams. Fish habitat and fish population studies remain essential to INFISH watershed analysis and should be supplemented by macroinvertebrate analysis which, in retrospect, showed promise to predict fish sensitivity to sedimentation in Basin Creek.

Macroinvertebrate sampling needs much greater use to be predictable and suffers from the problem that the FS only uses a single overworked analytical lab in Utah; hence, samples take more than a year to return results. Developing a local lab for macroinvertebrate sampling makes sense for the practicality of results and in the wake of recent Forest Service participation in local rural development.

The Bojonell and MacDonald studies point out two important factors that must be addressed in plan design: channel and flow differences among reaches and previous management activity. Monitoring locations must be compared to appropriate reference reaches with similar channel types, flow types, and historical management activity. Because budget constraints limit monitoring capabilities, most monitoring will continue to be tied to project monitoring and project funding. Thus rigorous design will mean that individual project monitoring sites (not all projects have water quality monitoring) must be selected under a forest-wide strategy, not arbitrarily as has been done in the past, so as to fit into a wider trend analysis of representative watershed conditions.

A strategic plan would develop a matrix of classifications, component conditions, and processes (data stratification) and attempt to systematically plan to monitor the relationships between them (standardized sampling procedures). Because most funding and "finality" (legal requirement) exist at the project level in the Forest Service, project monitoring programs, methodologies, analyses and reporting may be the level at which

public input and oversight can legally assure valid monitoring practices. The Forest Plan should be used to carry out the general Watershed Assessments envisioned by the Interior Columbia Basin Ecosystem Management Project:

"Watershed analysis is a procedure used to characterize the human, aquatic, riparian, and terrestrial features, conditions, processes, and interactions (collectively referred to as "ecosystem elements") within a watershed. In so doing, watershed analysis enhances our ability to estimate direct, indirect, and cumulative effects of our management activities and guide the general type, location, and sequence of appropriate management activities within a watershed." (REIC 1995:1)

My detailed recommendations for a strategic monitoring program and timetable appears in Appendix 5. A summary of key questions to be asked is provided here.

Key Questions that Need to Be Addressed during Forest Plan Revisions

- 1) What was the historical condition of riparian habitats and biological communities, what are the current conditions, and how do they compare to healthy riparian conditions?
- 2) What are the key indices of riparian health and degradation and how can they be tracked through time?
- 3) What would be a standardized sampling procedure to track riparian health and degradation through time?
- 4) What elements should be included in a database system, how can it be periodically updated, and how can the results be easily transferred to the public?
- 5) What are the analytical needs that are instrumental to summarizing data in a conclusive way that would feedback into management changes?

- 6) What will be the reporting frequency for monitoring and how will reports be formulated for peer and public review?
- 7) How will these analyses be used to direct management planning and policy?
- 8) How can funding for this program be assured for consistent monitoring results?

The Forest Service and the scientific reports alluded to in this report have already pointed out many key issues that must be answered if management is to respond to riparian health needs. First and foremost is the validation of an appropriate water yield model (or models)⁴ and the Forest Plan peak flow increase standard that continue to support high timber harvest levels even given grave concern over watershed conditions. The MacDonald et al. study was unable to validate the WATSED model using previous data and three years of their own team's research. Moreover the Forest Service has yet to provide a strategy for validating its standards and limits which should induce timber harvest restrictions. Post-fire water yield studies in the 4th of July Drainage found that openings and fire created longer durations of peak flows and increased water yields, but only for rain-on-snow events and peak spring run-off and not during events occurring in other times during the year (Dodd 1995; Luce 1997). MacDonald and Hoffman (1995) concluded that rain on spring snow events contribute most often to maximum flows on the KNF, while MacDonald et al. (1997) pointed out that qualitative channel changes begin with peak monthly flow increases as low as 6-8%. None of the studies suggested a means to validate the WATSED model.

Given the current inability to validate the model (i.e. to avoid the inconclusiveness of the model), it remains risky to continue basing management decisions about harvest

volume and project size on an index for which no validation strategy exists. Signs of over-management and poor watershed conditions abound from in-house watershed assessments, from sensitive and endangered fish populations, and from infield observations of mass wasting and channel instability. Actual infield conditions need to be better catalogued and compared to the historical stream and timber stand records. Following the analysis of concrete conditions, issue formation, the ideas that drive the need for and scope of a particular project, can proceed in a manner that will give restoration needs their proper due. Raising restoration to its proper role will likely produce budgetary problems that will necessitate increases in basic stumpage prices to meet them. Then, either funds will be collected for restoration and monitoring at the project level or high timber prices will leave sales unsold. Dropping harvest volume must be seen as a slow but methodical restoration process, a preferred alternative to risky continued harvest proposed with "inconclusive mitigation."

Channel Stability Ratings need to be redesigned as stream channel inventories that record quantitatively bank instability per mile, identify and map pool locations and measure pool length and large woody debris per mile, and qualitatively analyze other riparian habitat components and quality. An effort should be made to compare CSRs with Rosgen classifications to see if changing channel type changes assigned rating levels (Rosgen 1996; Sullivan 1996).

Finally, data analysis and report summaries must be made part of all monitoring activities. They should be presented for peer and public review at defined reporting frequencies and include public input and response mechanisms. Once the Forest Service

begins to approach data reporting and summation in a scientific manner, the burden of analysis and interpretation will shift to independent organizations such as universities, and trade and environmental groups. But for now, it remains the responsibility of the Forest Service to justify its actions through conclusive findings. Given current degraded conditions on the KNF, failure to reach conclusive results on the level of legal "finality" should instigate a drastic reduction of timber harvest activity and an increased emphasis on restoration projects. Monitoring demands strategic planning and consistency and these must be built into the Forest Plan Revisions. More importantly, strategic planning needs to be implemented in final decisions and enforced by public oversight. Unless the issues of strategic watershed planning (which allows project funding to be used for strategic monitoring objectives), consistency, finality of monitoring, and public oversight are resolved during the Forest Plan Revisions, the revised KNF Forest Plan should be rejected by environmental organizations. Resolution of these factors will require budgetary mechanisms that guarantee forest-wide funding for strategic planning and project funding for project monitoring analysis and reporting and these processes must be made evident in revision analysis. Waiting ten or fifteen more years for a monitoring program of utility is neither reasonable nor prudent.

Should the Forest Service fail to take conclusive steps towards effective monitoring in the coming Forest Plan Revisions, political tensions over forest management practices on National Forests will continue to rise. Rising tensions do not necessarily produce a ripe climate for progressive change. Therefore, while the Forest Service must carry the heavy burden to facing up to its past failure to meet its monitoring objectives, the environmental

community shoulders the responsibility to use revisions to open dialogue and seek positive changes in management direction. Science, rather than compromise, should be the measure of that dialogue.

¹ A good monitoring program should include the following (MacDonald et al. 1991):

- be sensitive and responsive to management actions
- have low spatial and temporal variability
- include variables that are easy to measure (accurate and precise)
- be related to beneficial uses
- involve early warning indicators
- represent broader or more complex ecological processes or subsystems

² Best Management Practices control timber harvest practices, regulating activities in ways to minimize ecological degradation, particularly the flow of surface sediments and road fill into creekbeds. Machine operation in riparian areas are restricted.

³ "[Watershed analysis] provides the watershed context for fishery protection, restoration, and enhancement efforts." (REIC 1995:1)

⁴ WATBAL, while no longer in vogue on the KNF, continues to be useful in predicting snow-dominated water yield from higher elevations and PROSPER offers an option for low lower elevational models.

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APPENDIX 1**The State of Riparian and Aquatic Habitat:
Monitoring the Monitors on the Kootenai National Forest***Following the Monitoring Items - What Was Done and What Has Changed?*

The Kootenai National Forest (KNF) administrators provide to the public the Annual Monitoring Reports as their only forest-wide summary reports of cumulative effects on various forest resources, including riparian areas. These annual reports, not actually required in the Forest Plan itself, are intended to synthesize the monitoring results from seven permanent trend stations and from site specific project monitoring in individual or grouped watersheds (physiographic areas of similar soil and topological characteristics). The seven trend stations have designated monitoring and reporting standards. As projects develop, watershed conditions in project areas are analyzed and schedules for monitoring and reporting are written into environmental assessments for individual projects. To date, no one, neither independent analysts nor the Forest Service, has attempted to assemble the findings found in the individual watershed analyses into a centralized database. Reasons for this are discussed in Appendix 3. For now, the public has to evaluate the Forest Plan and riparian monitoring achievements by either accepting the Annual Monitoring Report findings, which are developed from internal reviews of an unspecified character, or through independent investigations of piecemeal collections of data. This appendix assesses the condition of riparian and aquatic habitat monitoring by the two methods, first

analyzing the results in the Annual Monitoring Reports and then by discussing research and project findings since 1987.

The table format below addresses each of the nine annual monitoring items that have bearing on riparian habitat quality. For each monitoring item, a brief definition of management standards, monitoring objectives, and measurement methods for the item precedes the table. *Management standards* guide management decisions towards long-term resource objectives and provide a measure of resource protection "success." These standards are listed for each item. *Monitoring objectives* are desired goals for specific monitoring items. Monitoring determines achievement of management objectives through appropriate field methodology. The tables list policy changes during the decade's reporting period, identify ten-year monitoring trends, and report instream findings by the KNF. Dates refer to the year when the KNF reported results. A critical assessment of those findings by the author, along with recommendations for improvements, follows each monitoring item's table.

After discussing the nine monitoring items, an evaluation of site specific monitoring on the KNF since 1987 is made. Monitoring practices for instream stability, macroinvertebrate studies, and sedimentation rates are discussed in this section (snags are incorporated into the first section). Finally, a third section analyzes the results of a water yield/sedimentation study done by Colorado State University under a contract with the KNF. The Forest Service has stated that its future monitoring plan will be designed with detailed consideration to the recommendations of that study (KNF 1997).

The 1987-1997 Forest Plan Monitoring Summary based on the Annual Monitoring Reports

Monitoring Item C-5 Old Growth Habitat

management standard = protect 10% of the acreage below 5500 feet as old growth outside of the timber base

monitoring objective - guarantee that areas set aside are "effective old growth" - that is, already possessing functioning old growth components such as high snag density, multi-storied canopies, large trees, etc.

method of measurement - photo interpretation, timber stand exams, and field inventories

Reported:	Year	Findings
Changes in Policy	1991	Kootenai Forest Manual Supplement - allowed the designation of <i>replacement old growth</i> ¹ within a drainage rather than requiring the protection of old growth in adjacent drainages to make up deficiencies.
10-Year Trend in Monitoring		The Forest Plan set out to manage old growth near the minimum level for viable old growth dependent species (estimated at 8-10% of a drainage - McClelland 1977). Old growth validation was implemented in 1989 in response to a Save the Yaak Committee/CRG age class analysis that revealed continued proposed harvests in drainages deficient with old growth, supported by pressure from the Audubon Society. Old growth validation becomes mandatory prior to harvest unit design. Old growth inventory has improved and management level is slightly below its targeted 10% level (short about 90,000 acres forest-wide).
Results	1992	91,840 of 817,000 surveyed acres declared old growth; this is 11.2%. But since old growth acreage is only 84% effective, then only 9.4% of surveyed forest is actually effective old growth.
	1996	129,104 of 1,124,597 surveyed acres declared old growth; this is 11.5%. But since they are only 80.2% effective, then only 9.2% of surveyed forest is actually effective old growth.

¹ *Replacement old growth* refers to mature timber stands which do not, as of yet, show signs of large diameter trunk size, mixed canopy layers or decadence which create unique habitat niches for old growth dependent species. The hope is that, in time, barring fire or timber harvest, these mature stands will develop true old growth characteristics.

Criticisms: Restoration and recovery may hinge on understanding historical riparian stand conditions. The Forest Service (FS) has yet to calculate historical levels of riparian old growth or to graph the changes in riparian old growth through the years. (The Audubon Society attempted to analyze historical conditions of all old growth in 1994, but did not analyze upland/riparian ratios. Given the fire history of the KNF, there is reason to believe that riparian old growth was particularly important to certain plant/tree community associations such as cedar - *Thuja plicata*). With current information, it is difficult to assess the relative importance played naturally by riparian versus upland old growth stands. In fact, as stands are clearcut, the stand exam database of previous age and size classes is destroyed and replaced by seedling characteristics, thereby losing tracking information from which an estimate of historical conditions of old growth dependent Large Woody Debris (LWD) could be made. Using inventories of LWD tied to reference streams, as proposed under the Inland Native Fish Strategy (INFISH), it should be possible to reformulate historic conditions using earlier stand data on riparian timber age and size class distribution.¹

¹ A *timber stand* is an arbitrary management designation for an area of forest that has similar vegetative and geomorphologic parameters - i.e. a contiguous area, say, of old growth cedar/hemlock forest, facing northeast on a slope of 20-30%. Timber stands were originally taken from aerial photographs and then ground-truthed through Timber Stand Inventories - contracts where random samples (plots) are taken to measure tree age, size, density, disease, undergrowth vegetation and wildlife use. The entire forest has been divided into stands which are tracked through a centralized database. These have been mapped recently (1996) on GIS, allowing for relational analyses between riparian and stand information.

Also, examples from recent post-fire salvage environmental assessments indicate that the KNF has targeted low intensity burns in old growth for fire salvage, minimizing cost and maximizing timber returns (KNF 1994b; 1994c). This has occurred in watersheds that are old growth deficient already. Old growth in low intensity burn areas, with its *decadent and mixed canopy level*, may well reach *effective* old growth characteristics before unburned adjacent immature stands. The forest needs to develop a better understanding of old growth development processes in place of its timber output objectives to guide management project decisions. The Forest Service has not yet met its management standard under this Monitoring Item.

C-6 Cavity Nesters

management standard = 40% snag retention of the natural upland watershed snag potential (0.9 per acre)

and 60%-70% of riparian snag potential (1.35 per acre)

monitoring objective - to guarantee that snag densities left in harvested units are equal to the Forest Plan

standards and that the watershed contains appropriate snag densities over time

method of measurement - field inventories of snag survival and database analysis of areas yet uncut

Reported:	Year	Finding
Changes in Policy	1990	FS changed policy to leaving 2.25 snags per acre in all harvest units.
	post-1992	OSHA ¹ has increased its opposition to snag retention as a danger to loggers. Loggers are allowed to make in-forest decisions to cut snags for safety but must leave them as large downed woody debris for habitat.
10-Year Trend in Monitoring Practices		In place of true snag retention, live green trees are left as snags. Little post-harvest snag monitoring is done, though what has been done reveals continual problems with snag survival. No feedback loops are implemented to change policy for snag management and snag protection. Problems with snag density variation between areas, identified in Forest Plan, are never addressed.

Results	1992	First five years yield "inconclusive" ² results. Poor retention in harvest units is common but most drainages still have at least 40% of land unharvested. ³
	1996	First ten years yield "inconclusive" results. Post-harvest snag survival varies greatly between units. Live green trees are being marked as snag replacements but many do not survive the logging process.

¹ OSHA - the Occupational Safety and Health Administration

² *Inconclusive* is a Forest Service evaluation of its monitoring results. As can be seen below, the author takes strong exception to the use of *inconclusive* to describe KNF snag monitoring results.

³ The Annual Monitoring Reports assume that uncut forest has full snag potential remaining. However, the Forest Plan states that snag densities vary greatly and that old growth, not second growth or post-1910 fire stands, have greater snag densities. What constitutes 40% of natural potential in reality has yet to be determined.

Criticisms: The KNF has been unresponsive to public concern for increased snag protection and has ignored its own studies which, since the Upper Yaak Snag Survey in 1989 (Ferriman 1989), continue to indicate policy failure. The FS rejected the idea presented in the citizen's Alternative 10 in the Upper Yaak FEIS (KNF 1990b) to preselect areas of high snag concentrations and prepare special management plans for clumping and microsite protection. The Forest Service has not carried out systematic snag monitoring, but the Dry Fork Snag Survey, initiated in response to an appeal by the Cabinet Resource Group (CRG - see Appendix 2), demonstrated that even leaving high levels of snags was not insurance of survival success.

In that case, approximately seven snags per acre were marked in units, three times the Forest Plan standard (Ferguson 1991, personal communication). Of the 315 acres surveyed, 53% failed to meet Forest Plan snag retention standards following harvest, while

for the sale area averaged as a whole, snag retention levels reached 92.3% of the standards. The area, snag rich in large diameter burned larch, had to leave only 24.9% of the snags as green replacement trees (Froberg 1991). This study, the only one in ten years on the KNF that purposefully tried to leave extra snags and a to track them, would have had to leave 7.6 trees per acre to meet post-harvest standards. In fact, depredations due to post-harvest firewood gathering and windthrow would indicate that the level would need to be even higher to meet Forest Plan objectives.

No inventory of riparian snag ratios to non-riparian snags has ever been done, leaving the agency in the dark over snag densities in riparian zones and their natural ecological significance. Many of these would be natural recruitment trees for deficient LWD in streams (KNF 1993a). Putting the burden of snag retention on as yet uncut areas and high elevation unsuitable timberlands represents a failure of management policy and indicates management for snag extinction in the long-run. Green leave trees often blow over. No one has developed a model of snag creation that estimates how long it takes to develop appropriate snag density in new clearcuts. Finally, no accurate survey of snag densities and survival rates in former clearcuts exists from which modeled estimations of necessary snag density to meet its 40% potential levels could be formulated. It is fair to assume that previous emphasis on clearcutting old growth has severely reduced effective snag levels below the 40% level in many drainages. The Forest Service has failed to meet the intent of the management standard in this Monitoring Item and will eventually fall into noncompliance following present practices as more areas are harvested.

Monitoring Item C-8 Indicator Species

management standard = maintenance at 40% potential natural population

monitoring objective - rather than directly measure populations, the objective is to see that 40% of the habitat is maintained in condition conducive to native population existence

method of measurement - varies by species; no specific riparian methodology established but forest tracks item through redd counts (dropped in 1997) and population studies by snorkeling and electroshocking

Reported:	Year	Finding
Changes in Policy	1991	KNF began reporting miles of streams with sensitive fish populations.
	1992	KNF reports 850 miles of identified sensitive fish fisheries for Interior Redband rainbow trout, westslope cutthroat trout, Shorthead sculpin, and bull trout.
	1994	Montanore Project File lists Tailed-frog as sensitive species in Montana.
10-Year Trend in Monitoring Practices	The Forest Service relied on project monitoring and monitoring by state biologists to determine sensitive fish population rather than establish a direct monitoring program to understand condition for fish forest-wide.	
Results	1987	No indicator species for riparian conditions was named in Forest Plan.
	1992	Item dropped from riparian considerations.

Criticisms: While neither systematic nor extensive, the KNF has proceeded with inventorying creeks for sensitive (rather than indicator) species and spawning redds whenever projects are planned. However, even knowing that bull trout are declining in number (Perkinson 1994), the KNF established no procedures for monitoring bull trout. The existence of tailed frogs in Little Cherry Creek, which is highly sensitive to sedimentation according to the Montanore Project File, was not even mentioned in the Forest Service's EIS for the mine. Sedimentation build-up has not been monitored systematically on the KNF during the past ten years but headwater accumulation rates was

studied that showed increased sedimentation below riparian clearcuts (Bojonell 1993). However, the Forest Service continued to harvest in riparian areas, ignoring the studies results, until INFISH standards limited SMZ harvest in 1995.

With the probable listing of bull trout, better monitoring of fish populations will be required. This has also been recommended by the Scientific Committee of the ICBEMP (ICBEMP 1996). Not only are studies needed about population sizes, but correlations between populations and stream conditions need to be better categorized. Improved and more frequent Channel Stability evaluations are needed to record differences between streams in channel morphology and sensitive fish populations.

Monitoring Item F-1 Soil and Water Conservation Practices (BMPs)

management standard = to meet state standards (<5% increase in sedimentation); 1988 changed to

implement effective BMPs 100% of time

monitoring objective - to prove the state is meeting state water conservation standards

method of measurement - prior to 1988: turbidity, stream temperature, total suspended solids (TSS), and streamflow; in 1988, changed to BMP evaluations

Reported:	Year	Finding
Changes in Policy	1988	BMP implementation replaces instream monitoring to prove that the Forest Service is "meeting state standards."
	1993	Standard changed to 100% BMP implementation and 90% BMP effectiveness when implemented [risk factor = .1 = 1 - (1 X .9) = 10%]
10-Year Trend in Monitoring Practices	BMP monitoring has become principal monitoring device for Monitoring Items C-9, C-10, F-1, and F-2. Originally it was intended to serve F-1. BMP effectiveness has reduced risk as measured by the Forest Service but not by state.	

Results	1990	Forest Service began using BMPs to measure this item. Standard set at 100% BMP implementation and 100% BMP effectiveness.
	1990 - 1996	The Forest Service measured implementation and effectiveness percent for BMPs on various timber sales (see Chart A-1.1 below).
	1990 1992 1994 1996	The Montana Department of State Lands makes BMP Audits of infield implementation and effectiveness of BMPs on the KNF.
	1991 1992 1995	Forest Service found BMP problems that rated below current Standards of 100% BMP implementation and 90% BMP effectiveness. Reasons for problems: lack of training for sales administrators; poor sampling procedures by state; on-going projects prior to BMP regulations; old roads do not meet current BMP standards.
	1996	Only year when the DSL found full compliance with current Standards.

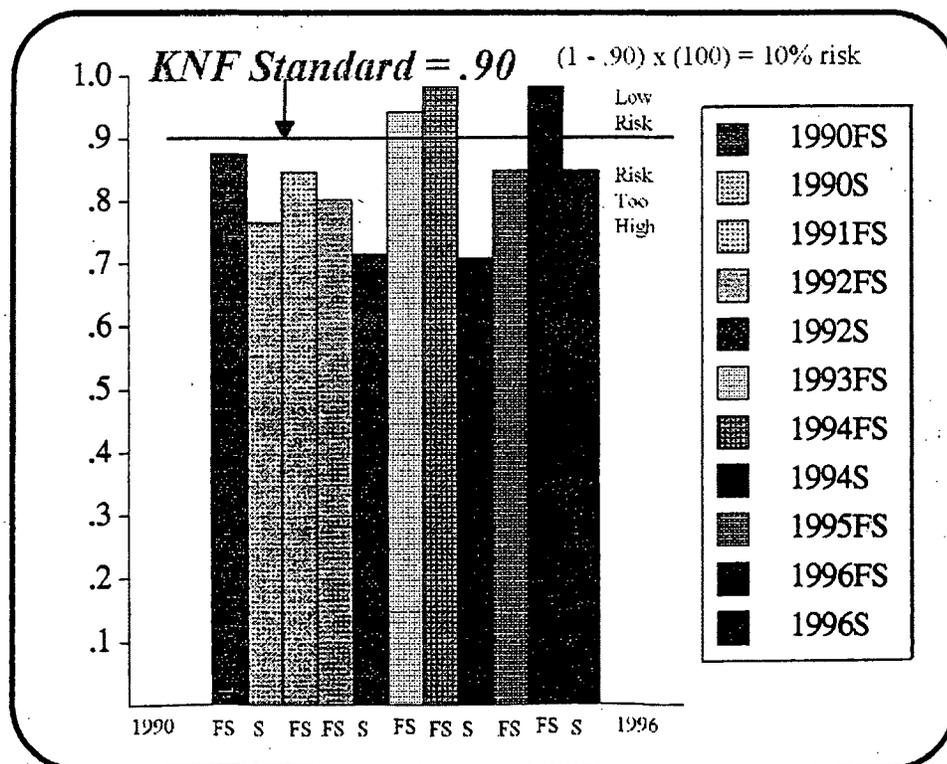
Criticisms: CRG continues to maintain that, while valuable, BMP monitoring does not measure riparian habitat quality, aquatic habitat quality, degradation (event or chronic), or restoration needs and success. BMP monitoring is useful in assessing management-induced sedimentation risks *after a project is decided upon and carried out, but it is not useful in guiding management decisions on where or when activities should be done.* Furthermore, an honest evaluation of management-induced risk to aquatic habitat health requires the calculation of a risk assessment factor by multiplying an implementation score times an effectiveness score. This risk factor is then subtracted from one and multiplied by 100 to get a percent:

$$\text{implementation} \times \text{effectiveness} = \text{risk - factor}$$

$$(1 - \text{risk - factor}) \times 100 = \% \text{ induced risk from management}$$

Estimated risk of potential negative aquatic habitat effects from timber management activities based on Forest Service monitoring (KNF 1997) is: 12.6% (1990); 15.5% (1991); 20% (1992); 6% (1993); 2% (1994); 15.4% (1995); and 2% (1996). Estimated risk based on state monitoring is: 23.6% (1990); 28.6% (1992); 29.4% (1994) and 15.4% (1996). Risk estimates may be biased because sampling procedures are not statistically random. Even accepting the 1993 proposed threshold of 10% risk factor, clearly, over the last ten years, the Forest Service has not met the management standard for this Monitoring Item. BMP use and monitoring should continue as BMPs assist the management objective of preventing excessive harvest-induced sedimentation. But BMPs are no substitute for the evaluation of the quality of riparian or aquatic habitat (see F-2, C-9, and C-10 below).

Chart A-1.1 Sampled Risk Factors of BMPs by FS and State Audits 1990-96



Monitoring Item F-2 Stream Sedimentation

management standards = 20% increase over background in bedload movement and suspended solids

monitoring objective - to determine sediment impacts on fishery habitat

method of measurement - bedload movement, suspended solids, and streamflow monitoring at seven

trend monitoring stations

Reported:	Year	Findings
Changes in Policy	1988 - 1989	Added channel cross sections and RSI ¹ to small stream inventories across the forest.
	1992	Changed pebble count methodology making earlier measurements useless. R1/R4 Sedimentation Model gives way to WATSED for sedimentation modeling. ²
	1995 - 1996	FS begins suspended sediment measurements in small streams. Study show that state sediment standards are exceeded even when BMPs are administered.
	1996	FS drops bedload measurements due to high water collection difficulties.
10-Year Trend		Monitoring remained unsystematic and variables and their limits of variation continued to evolve and change at the Forest Service's discretion. Older data rarely fit with newer data so that trend monitoring capabilities were reduced. The quality of monitoring was increased but it was not tied to specific monitoring objectives.
Results	1988 - 1991	Very little monitoring of the seven Forest Plan water and sediment model validation sites was done.
	1991	Natural variation is identified as a problem in validation analysis.
	1992	Natural variation continues to plague monitoring. The Forest Service realizes that its target validation sites are too large to show timber harvest effects and sedimentation changes. Results remain inconclusive and FS says changes are needed to improve sedimentation calculations for model validation and predictions.
	1992	26% of all measured (including mixed-ownership) drainages already exceed water yield guidelines. 12% of Forest Service-managed drainages exceed PFI ³ limits and 29% more are at their watershed condition limits so as to constrain future activity.
	1996	Forest Service states it lacks a computer model to analyze its stream channel cross section data. FS states that RSI measurements are useful only on large streams. FS lacks enough reference data for proper analysis. Sediment monitoring reveals high turbidity levels following all harvests which fail to meet state standards regardless of BMP implementation.

Results (cont.)	1997	Forest Service points to the following monitoring difficulties: 1) the variability limit (20% change in bedload movement) is unrealistic; 2) monitoring focuses on large streams while harvest is mostly on small ones; 3) techniques in past have failed, needing greater structure to data collection, monitoring intervals, and computer support; 4) the monitoring program is unfocused.
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¹ Channel cross sections, which measure the shape of a channel at a given place, reveal channel changes through time and theoretically can be tied to streamflow discharge rates and increased water yields to measure instream effects from timber harvest and roadbuilding. The Riffle (Armor) Stability Index (RASI or RSI) measures the particle size of bedload deposits on gravel bars from high flows and compares them to streambed particle size in normal flow riffles. Thus, it is a measure of streambed stability during high peak flows.

² Neither the R1/R4 Sedimentation Model nor the WATSED Model have ever been calibrated and validated for the KNF. Recent calculation by the Canoe Gulch District indicate that WATSED may prove useful for water yield calculations but is not very accurate as a sediment prediction tool.

³ Peak Flow Increases (PFI) are the % increase in peak monthly flows from April, May and June resulting from increased water yields due to timber harvests, a combination of reduced canopy interception and increased rate of snowmelt.

Criticisms: The Forest Service responded slowly to its own feedback loops. In 1991, natural variation was recognized as a validation problem; in 1992, inadequacy of site selection for the measurement of harvest effects on channel stability and the meagerness of data for model validation were noted. The 1993 Advisory 5-Year Review (KNF 1993b) recommended changing the variables to be measured and spreading those measurements to smaller watersheds with management activities. Two technician positions for field monitoring, two coordinators, and one data collection and compilation technician at the cost of \$90,000 were planned. However, no strategic plan to tie this new work to

problems of natural variation, inadequate site selection, lack of reference streams or model validation, was developed. *Problems identified in the monitoring reports were not corrected.*

The Forest Service added to the confusion by making the claim in 1996 that computer models to evaluate cross section changes don't exist. While it is clear that computer software does exist and is readily available from the EPA (WENRESS), the Region One office (R4CROSS), and even the Internet, it is worrisome that costly time consuming cross section monitoring has been employed with no predetermined purpose. The WATSED model, never opened to peer review before its implementation, has not proven to be a valid tool in sedimentation estimations (Wegner 1996, pers. com.). However, recent changes in its measurement techniques may prove useful if a program of strategic monitoring and reference streams can be developed. The Forest Service has been unable to meet the management standards or the monitoring objectives for this Monitoring Item.

Monitoring Item C-9 Riparian Habitat

management standards = 1987 - maintenance of sport fisheries at 90% current level; 1992 - meet state

standards; 1997 - implement INFISH guidelines; maintain 70% riparian snag potential

monitoring objective - to determine if riparian habitat was being adequately protected

method of measurement - never clearly stated; use summation of Items C-10, F-1, and F-2 + mapping

Reported:	Year	Finding
Changes in Policy	1990	The FS implemented BMPs in timber sales forest-wide.
	1991	The FS implemented Riparian Guidelines and Streamside Management Zones (SMZ) but the KNF makes width smaller (100 feet) than field studies show it is naturally. ¹
	1994	Montana SMZ Law regulates riparian harvest on private land; reduces SMZ width to 50 feet on KNF; restricts machine entry in wetlands.
	1995	INFISH widens SMZs to 300 feet and sets up priority classification for fish bearing streams.
10-Year Trend in Monitoring	Introduction of BMPs in place of instream monitoring; implementing an unclear and changing SMZ policy, but overall trend toward widening; classification also replaces variable monitoring.	
Results	1992	Inconclusive riparian habitat quality monitoring to date; but 2166 miles of 28,560 miles of stream on the KNF have been classified and mapped.
	1996	Inconclusive monitoring to date. 2348 miles of perennial stream and 1747 miles of intermittent streams have been classified and mapped.
	1988 - 1996	Restoration activity accomplished projects in 6200 acres of riparian habitat.

¹ Pfister et al. (1991) contracted to examine widths of riparian zones on a sample of KNF streams. They found riparian widths from 69 feet to over 1300 feet, with 350-600 foot wide SMZs being common.

Criticisms: Classification by streamflow regime and the presence or absence of fish populations is important baseline data but it is a simplistic and poor description of the quality of riparian habitat. First, no mapping of historical vegetative conditions have been attempted (see C-5 above). Second, important factors like one- and two-sided riparian harvest, large woody debris accumulations, potential recruitment trees, snag densities, wetland sizes and wetland plant communities have not been tracked or mapped. Third, while studying fish populations is useful in those streams where fish are present, it says nothing of previous degradation and habitat loss in areas of former ranges (Gresswell 1988). Which streams used to have viable fish populations and what riparian characteristics supported them? Fourth, implementation of Riparian Habitat Conservation

Area (RHCA) widths (now 300 feet in INFISH) are late responses that follow years of agency foot-dragging to protect streamside riparian zones. The cumulative riparian effects of management, such as the effects from streambank clearcutting in the early Forest Plan years, are not discussed in summary Annual Monitoring Reports. Finally, BMPs are covered in Monitoring Item F-1 (see below) and *are not* a measure of riparian habitat quality, effectiveness or condition. *BMP implementation is not a valid substitution for monitoring riparian habitat condition. The Forest Service has failed miserably to record, measure, and classify key riparian habitat quality components. It has failed to establish management standards and criteria and avoided the proposed monitoring objectives behind this monitoring item.*

Monitoring Item C-10 Fisheries Habitat

management standards = +/- 10% change in Redds (dropped 1997); +/- 2 degrees in stream temperature;

+/- 10% change in sediment (dropped 1997); +/- 10% change in embeddedness; +/- 20% change in debris accumulations

monitoring objectives - to assure changes in fish habitat and numbers do not exceed predicted declines

method of measurement - stream surveys, core samples, temperature recordings, debris and redd count

surveys and embeddedness at seven trend monitoring stations

Reported:	Year	Findings
Changes in Policy	1990	Began to emphasize BMP implementation over instream monitoring of Forest Plan Guideline variables.
	1991	Monitoring Report tracked item by miles of sensitive fish locations rather than by redd location, stream temperatures, sediment changes, embeddedness and LWD as stated in Forest Plan.
	1993	5 year report indicates that data has been collected consistently on only 5 of 7 representative Forest Plan Monitoring sites

Changes in Policy (cont.)	1994	No monitoring of fish habitat accomplished.
	1996	Forest Service announced it is dropping redd counts and substrate cores. It will continue with stream temperatures, embeddedness, and LWD in some sites while INFISH takes precedence (RHCAs, salvage, BMPs)
10-Year Trend in Monitoring	Lacking a strategic plan, monitoring of instream variables was unsystematic and results are incapable of proving the protection of beneficial uses. Site specific monitoring tied to timber sale funds is done prior to timber sale activity.	
Results	1988 - 1989	Monitoring program was not implemented. BMP training began in 1989.
	1991	75 watersheds have portions surveyed, with 24 containing sensitive fish populations. Forest Service estimates 850 miles of sensitive fish habitat.
	1992	Prediction reliability of monitoring still listed as <i>moderate to high</i> . 43 watersheds inventoried as having sensitive species populations.
	1996	Forest Service reverses its opinion and calls its monitoring program <i>inconclusive</i> . Says discriminatory power of variable is low and likelihood of faulty conclusion <i>high</i> .

Criticisms: Without a Strategic Watershed Plan to guide monitoring, direction on how to monitor for the C-10 Forest Plan variables was absent. Even though the *reliability*² was expected to be "moderate to high," the Forest Service failed to monitor this variable and did not address its unsystematic methodology even when noted (KNF 1993a).

Measurements have been sporadic, untimely, and not tied to management goals or objectives. The trend to monitor BMPs does not establish a database capable of detecting natural variation or management induced changes in riparian habitat, short-term or chronic. Lack of implementation of variable monitoring makes it impossible, after ten years, to assess the reliability of the parameters. The Forest Service has yet to answer the question: "What are quality fish habitat components and how can they be tallied and their processes surveyed?" The intent of this item is to measure quantitatively important

² *High reliability* means that results from the proposed monitoring methods are expected to show decisively what effects timber harvest is having on fish habitat.

variables related to fish habitat. LWD concentrations, pool in-filling, riparian width, recruitment tree potential, and dissolved oxygen are all far better alternatives than BMPs if the object is to understand the quality of fish habitat. The Forest Service has failed to implement the monitoring program for this Monitoring Item.

Monitoring Item F-3 Water Yield Increases

management standards = 20% increase in channel stability rating (dropped 1993); 20% of watersheds exceed water yield guidelines

monitoring objective - to determine cumulative water yield increases for April, May and June and resulting sedimentation impacts

method of measurement - recording crest gauges, channel surveys, and KNF Forest Plan Water Yield calculations based on clearcut equivalents

Reported:	Year	Findings
Changes in Policy	1992	Channel Stability Rating dropped as a rating of hydrological compliance.
	1993	Deferral <i>or</i> mitigation allowed when over the Allowable Peak Flow Increase limits. WATSED replaced older water yield models.
10-Year Trend in Monitoring Practices	Channel Stability Ratings were continued for alternative comparisons but dropped as a means to validate management practices. KNF Water Yield Guidelines were replaced by WATSED calculations for Peak Flow Increases. Peak Flow limits were generally kept below 14% in non-salvage areas but higher in salvage locations. Model validation remained elusive, even when it was contracted out.	
Results	1988 - 1992	26% of all inventoried watersheds are found to have peak flow increases greater than limits set by the Forest Plan. Private harvests are the over-riding problem in trying to meet allowable water yields. Projects in these areas will be deferred (presumably until water yield recovery), but FS concludes that there is no need for a feedback loop to change standards.
	1993	The Forest Service is out of compliance as FS is unable to "calibrate and/or validate the water yield guidelines" (KNF 1993a:2) because 1) FS was not clear on how recording and crest gauges would be evaluated; 2) FS was not clear whether to calculate <i>existing or existing and proposed</i> harvests in its models; 3) FS lacks post-harvest monitoring funds; and 4) CSRs are unreliable to determine 20% change in water yields and because response-time to peak flow increases often have longer than the 5 or ten year reporting frames; and 5) WATSED had replaced other methodology.

Results (cont.)	1996	24% of inventoried watersheds continue to be beyond Forest Plan water yield limitations. Wildfires are the current cause of continued noncompliance.
	1988-1992	Channel Stability Ratings, ¹ a standard used to determine levels of Allowable Peak Flow Increases, were never reported in Monitoring Reports.

¹ Channel Stability Ratings (Pfankuch 1978) are instream channel evaluations which tabulate a score based on a wide variety of variables related to channel stability. The score is added and a condition assessment (excellent, good, fair, poor) is used to determine allowable peak flows (between 12% and 20%) in the watershed. Dropped as a peak flow level indicator for Forest Plan monitoring in 1993, CSRs continue to be used for project-level analyses.

Criticism: The Forest Service improved its calculations of model prediction for peak flow increases (WATSED water yield) but has not validated or calibrated the model to date. While the model is useful in indicating relative peak flow changes from various proposed harvest levels in a drainage, it is not necessarily accurate as to real water yield increases nor linked to levels of degradation or inchannel instability. Thus, the model is of little predictive use in determining whether beneficial uses are being protected and whether chronic degradation is occurring in the streams. During the first five years (1988-92), the Monitoring Reports indicated that timber harvest deferral would occur within streams over the modeled hydrologic water yield limit. Since then, mitigation, rather than deferral, has been considered, allowing re-entry even into watersheds beyond the limit if reentry can be justified by other reasons (particularly speeding hydrological recovery through revegetation following salvage harvests). *The Forest Service did not implement feedback loops when hydrologic standards were exceeded but continued for six years to say that they would improve.* This practice is distressing, in and of itself, as it implies that feedback

loops are discretionary and outside of public review. Furthermore, the KNF practice of harvesting to a 14-16% PFI limit may be maxing out streamflows throughout the forest (see MacDonald et al. 1997 recommendations, Appendix 6). The Forest Service has been unable to meet the management standards or monitoring objectives for this Monitoring Item.

Monitoring Item F-4 Soil Productivity Change

management standard = <15% decrease in site productivity due to compaction and overland sediment transport

monitoring objective - determine changes in site quality

method of measurement - visual inspection on transects in sample harvest units

Reported:	Year	Findings
Changes in Policy	1996	None.
10-Year Trend in Monitoring	BMP implementation has reduced the number of problem areas. Alternative harvesting methods also have reduced compaction and ground disturbance.	
Results	1988 - 1996	16% of the areas sampled have a greater than 15% negative ground disturbance. Sample size is too small to be reliable.

Criticism: While in technical *non-compliance*, the 1% differential is small and all indications, if this was an accurate random sample, would show that compliance is now being reached. The Forest Service is approaching meeting the management objectives of this monitoring item. However, the measurement of compaction and sediment transport rates requires sophisticated equipment and investigation, and the Forest Service has replaced a quantitative standard with a qualitative investigation.

Summary of Forest Plan Monitoring Success

In sum, where management activity and monitoring have occurred, not a single management standard has been met and many monitoring objectives remain elusive. Soil Productivity (F-4) is close to compliance and snag habitat (C-6) is in serious decline in number and quality, though possibly still above its technical Forest Plan threshold. Old growth retention (C-5) and water yield levels (F-3) are being managed at levels which do not meet Forest Plan standards and guidelines. Riparian Habitat (C-9) is being classified by stream type and channel morphology, but other critical riparian habitat conditions are not monitored, recorded, or put into a database. Nor is a picture of historical conditions being developed. A riparian indicator species (C-8) has not been delineated; instead, this indicator had been replaced by the recording of sensitive fish species. Fisheries Habitat (C-10) monitoring is in a state of chaos and not valid in determining fish populations or managerial effects. No official monitoring is being done but miles of sensitive fish habitat is being classified. BMP (F-1) usage is improving but it, too, fails to meet current criteria when a risk assessment is made. Thus, *on-going harvest activities under modern BMPs are still inducing degradation risks beyond acceptable limits.* Parameters for Stream Sedimentation (F-2) monitoring have been constantly changed so that virtually no usable baseline data was recorded in the first ten years of the Forest Plan even though 61,182 acres of timber have been harvested in the meantime and two major fires have burned over 26,000 additional acres. Taken as whole, the report card on monitoring written by the Forest Service itself is not particularly encouraging in light of state laws requiring the "maintenance and improvement" of beneficial uses. Methodology for the monitoring

program has not been systematic or strategic in any scientific sense, nor have the monitoring reports been particularly useful to the public in assessing instream conditions and riparian habitat. The need for drastic changes are clearly due.

Assessing Site Specific Monitoring to Better Understand Riparian Habitat

The lack of summary reports for site specific project monitoring by the KNF makes it difficult for outsiders to understand what monitoring has achieved on the forest and how timber harvest is affecting the riparian environment. There is more going on than meets the eye. The KNF has been monitoring site specific locations on each district to assess watershed conditions besides following its basic Forest Plan monitoring program. These site specific monitoring projects are primarily financed by proposed timber sales and thus it is fair to say that no monitoring on the KNF is "random sampling."³ Except for the seven permanent stations,⁴ originally planned to establish long-term harvest-aquatic health trends, monitoring and timber management are usually united. Around 1994, following the arousal of interest in ecosystem analysis, the KNF redesigned its timber sale assessment process to include the analysis of physiographic areas - watersheds of similar geomorphology, often four or five adjacent drainages. By creating larger areas, the KNF

³ The main exception to this statement are the Canoe Gulch ISCO sampling of nine stations designed to validate the R1-WATSED model for predicted water yield and sediment increases.

⁴ The seven permanent stations were supposed to measure timber harvest-channel stability relationships and were to be used for sedimentation and water yield model validation (KNF 1987). Chosen because they were sites with previous data for trend analysis, they have proven poor sites for either Forest Plan purpose. They no longer are tied to specific monitoring objectives, yet monitoring continues.

could collect funds from area timber sales to (1) classify channel type, (2) do Channel Stability Ratings, and (3) calculate Riffle Armor Stability Indices of bedload movement over a broader area. These smaller site specific monitoring projects (see Table A-1.2, pg. 36) are used for baseline data for models comparing alternatives during proposed projects in Environmental Assessments but rarely tied to Forest Plan Monitoring objectives .

Approximately 4100 miles of stream, perennial and intermittent, have been classified either by Rosgen Classifications (geomorphology, gradient, sinuosity, and entrenchment, width/depth ratios), by Kootenai Riparian Classification (large or small, perennial or intermittent, or dry) or by INFISH Categories (fish bearing or not, perennial or intermittent, standing water). Unfortunately, the three classification systems use different criteria for classifying reaches, making comparisons between them difficult when they are on the same stream. (A reach is a contiguous portion of a stream with similar characteristics). The claim that 4100 miles have been categorized is somewhat misleading. A means is needed to track all three classifications on a single relational database.

To further complicate the issue, Channel Stability Ratings, a regional standard since the late 1970s, often used entirely different reach segments when repeated in a drainage, and rarely do CSR reaches overlap Rosgen or KNF Classification reaches. Due to the CSR's early inception, many streams have three sets of CSRs through the years that should allow temporal comparisons; however, reaches were rarely the same and it remains a computer nightmare to make sense of the changes. The Channel Stability Ratings remain valuable in that each one represents an instream quality evaluation of both aquatic and riparian habitat

and in many areas they represent the only historical record of actual stream conditions. The rating forms require that the inspector evaluate many stream variables, rating them and then scoring the watershed condition. Unfortunately, the Forest Service does not look at the actual problems but uses only score summaries in its analyses, losing the essential fact that two scores of 99, for example, may be due to entirely different problems.

The Idaho Panhandle National Forest spent twenty years developing the RASI (or RSI) - the Riffle (Armor) Stability Index before pressure from environmental organizations led to its importation for use in 1991 to the KNF. The RSI attempts to judge bedload movement in a stream by comparing the size of riffle bed material to the size of bed material being transported to gravel bars during high water. There is some question as to its usefulness in small headwater streams (KNF 1997). RSIs, CSRs, and Rosgen Classifications were suspended on parts of the Forest when INFISH was implemented in 1996 but continued to be monitored in other areas.

Channel cross sections are also commonly tied to permanent location markers (benchmarks) in a manner that allows a certain reach to be measured over and over again. The hope is to tie channel changes to peak flow increases through computer modeling in the future. Despite little evidence of short-term utility, the time consuming cross sections have limited the hydrologists' time available for monitoring other variables across the forest, especially in reference streams. Even after seven years of collecting data, the Forest Service has not chosen a computer model to use for cross section analysis (KNF

1997) although many programs exist and are available from other agencies (EPA and Region One Office) or over the Internet.

Monitoring is also done at specific monitoring stations in an attempt to relate flow regimes to sediment transport and timber harvest: 5 stations in Swamp-Edna; 39 stations on 18 creeks on the Three Rivers District; 24 flow stations on the Canoe Gulch district with nine ISCO sampling stations to calibrate the KNF water yield model; seven Forest Plan monitoring sites (Sunday Creek having been divided into two smaller ones on Blessed and Advent Creek); at mine adit and tailings ponds; and at several USGS sites. The Rexford District initiated flow stations in 1995.

Both the Districts and the Montana Fish, Wildlife and Parks Department do fish population surveys. The prime concern of these studies is to identify areas supporting sensitive and endangered species. Another survey type, macroinvertebrate surveys,⁵ offers interesting possibilities. From 1991-1993, the Three Rivers District surveyed creeks in the Upper Yaak in which ratios of taxa were counted and compared to a Biotic Index. A problem occurred in that only one lab (the National Aquatic Ecosystem Monitoring Center, Provo, Utah) is used to analyze these samples, and their backlog of work often delayed sample results for over a year and a half. The study has shown drops in macroinvertebrate organisms between summer and fall, indicating the need to use careful

⁵ Macroinvertebrate surveys sample aquatic invertebrates (insects, crustaceans, segmented worms) that live on the bottom of streams. *Macro* means they are large enough to be seen by the unaided eye. Because these invertebrates do not move around much and have specific habitat needs, their presence and abundance can be used to indicate habitat conditions over time.

and repeated sampling for trend monitoring. However, sampling in Basin Creek appears fine enough to show macroinvertebrate population declines from effects of sedimentation problems associated with roadbuilding in the East East Fork Tributary. This sedimentation was later corroborated by other monitoring methods used for the Basin Creek EIS (KNF 1996b). Macroinvertebrate populations tumbled shortly after roadbuilding and, two years later, remained at depressed levels (Mangum 1993). The macroinvertebrate methodology offers a quantitative way to assess potential aquatic problem areas, though the Biotic Index would need to be validated for the KNF.

The Forest Service began to assemble its aquatic and riparian monitoring documentation into systematic files after 1992 and only now is entering the information into computerized database files. Until this is finished, neither the agency nor independent individuals and groups will be able to use the information for cumulative effects analysis and revision of trend monitoring practices. The public still awaits interim monitoring analyses and reports from most site specific projects and from the seven trend monitoring stations. Since projects are geared to run for five or ten years, the public and other agencies expect some results from these projects prior to making comments on proposed Forest Plan Revisions.

Site Monitoring Reports Still Lacking Analysis

- 1) Camp-Everett Timber Sale Monitoring 1985-1990 - reports were due 1991;
- 2) Swamp-Edna Timber Sale Monitoring 1989-1999- due 1997;
- 3) 4th of July Creek Burn Monitoring 1992-2000 - reports due yearly;
- 4) East Fortine Monitoring 1991-2001 - yearly reports with summaries at 3, 5, and 10 years;

- 5) Arbo Creek Monitoring 1992-2000 - reports due yearly;
- 6) Upper Yaak EIS Monitoring 1990-2000 - reports due yearly with summaries at 5 and 10 years;
- 7) Upper Yaak 316 Sale Monitoring 1991-2001 - reports due yearly with summaries at 5 and 10 years.

One particularly distressing analysis came in the Compartment 2 Lodgepole Pine Salvage EA (KNF 1994d) which reported that a 1984 core sampling showed spawning areas to have deposited fines (< 6.35 mm) in excess of 40%. Dramatic salmonid fry emergence failure occurs as fines rise from 20-30% (Stowell et al. 1983; MacDonald et al. 1991), yet the analysis goes on to support increased harvests that were predicted to raise sediment levels within the creek. In nearby Dodge Creek, an estimated 50-60% fines in channel substrates did not stop harvest or grazing allotments:

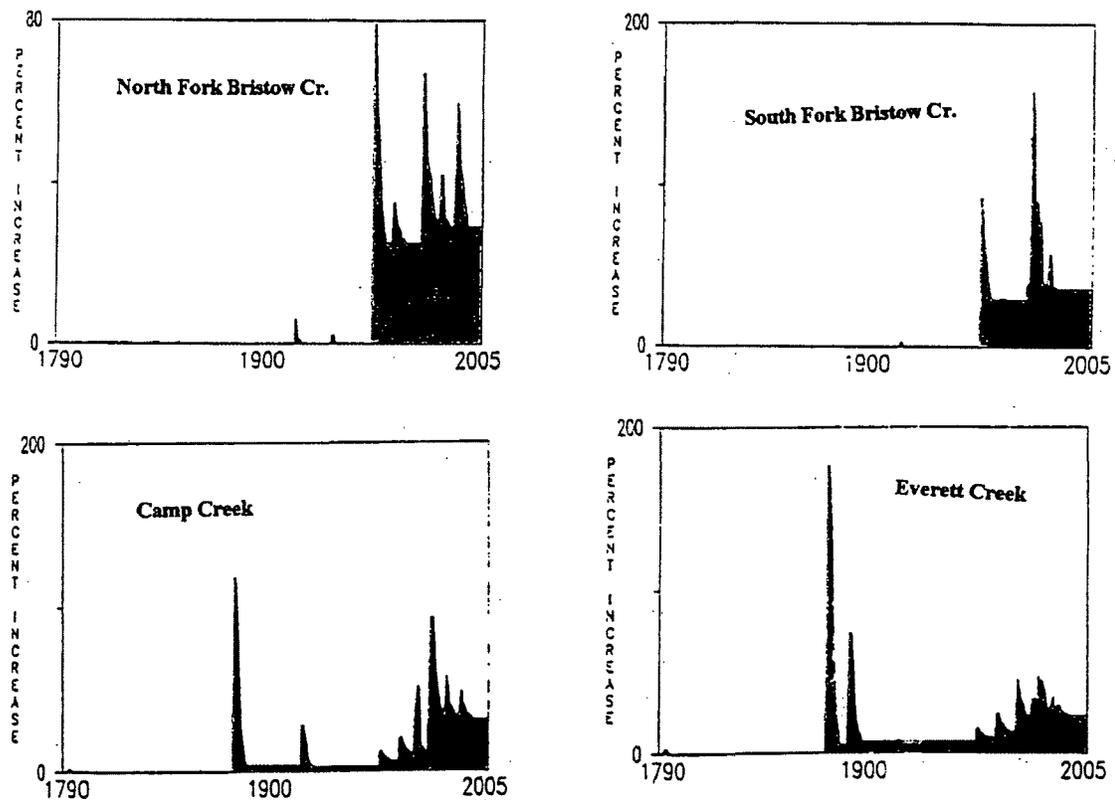
"Frankly, the sediment conditions in this reach of Dodge Creek are the worst I have observed on the Kootenai NF - even in comparable stream settings. ... Complete recovery of inchannel habitat conditions for trout and westslope cutthroat in particular, is many decades away." (Perkinson 1992:1-2)

In addition to these rare summary reports, the public awaits reports on the seven Forest Plan validation stations. To date, only brief summaries of the monitoring results from these stations have been presented in the annual Forest Plan Monitoring Report, but no conclusive analysis nor comparative analysis between them have been produced. The Forest Plan says that monitoring reports will be produced either annually, at two year intervals or at five year intervals depending on the variables being monitored at the individual station.

On the Issue of Recovery

Monitoring results from many sources indicate that recovery of riparian systems to natural states is a long-term process with no easy solutions (KNF 1987; Yount and Niemi 1990; Callahan 1996; MacDonald et al. 1997). Recovery to new steady-state, albeit somewhat degraded conditions, is much more rapid. Bristow Creek graphs of sediment curves in the mainstem show that a post-harvest increase of 65% over natural

Chart A-1.2 Predicted Bristow Creek Sedimentation Increases (KNF 1996b)



sedimentation levels reached a steady state of 30% above natural conditions within a few years after harvest (see Chart A-1.2). Additional harvest introduces only short-duration

increases in sedimentation rates. However, post-harvest sedimentation has not dropped to "natural levels" in twenty years.

When sediment transport into Bristow Creek was discovered from a roadcrossing, the area was monitored for sediment until corrective measures took effect. That problem corrected itself to a steady state in two years, though sediment readings below the culvert continued to remain much higher than those above the culvert. Recovery in this site specific case was to a level above natural levels, one example of why the KNF states that it is unable to meet state standards which say that there should be no increase above background levels (KNF 1993a; KNF 1997).

Recovery of macroinvertebrate populations following sedimentation smothering or high flow disturbance has been shown to be a two to five year process in other western streams, though careful consideration has to be given to taxa represented in "recovered samples" as some taxa are more susceptible to long-term elimination than others (Yount and Niemi 1990).

Recovery of water yields remains difficult to assess. The North Fork Fire Recovery EIS estimated that hydrologic recovery begins in 5-10 years. The Forest Plan predicts that clearcuts reach 50% water yield increase recovery in 20-30 years and full recovery in 28-50 years, depending on the recovery rate potential of individual streams. In the Northern Rockies Ecosystem, peak flows usually occur before the onset of vegetative transpiration in late spring and clearcut water yield recovery may be a function of canopy interception rather than transpiration, indicating recovery times of 25-60 years in this region (Callahan 1996). As has been stated, watershed condition assessments already

place 41% of the drainages on the KNF at hydrological limits and that recovery of these areas should not be expected within the next ten year planning period.

Recovery of large woody debris requires even more time. Recruitment of LWD requires the regrowth, death, rotting, and transport of large diameter trees into the channel. Based on my seven years of doing timber stand inventories on the Kootenai National Forest, I would estimate that it takes 100-160 years for a 12-14" diameter tree to grow, 15-30 years as a standing snag, and then luck to fall into the channel instead of away from it. One hundred and fifty years in recovery is not unlikely. Luckily, LWD is an area where human activity can speed recovery, though one must be willing to accept some additional sedimentation from LWD due to channel changes and re-entry to re-establish and augment LWD when sediment traps fill (KNF 1996a). The one study of restorative LWD and pool recovery efforts was made by Perkinson (1989) on Graves, Boulder, and Sutton Creeks in the Rexford District. In spite of a small sample size, he concluded that the effort had been successful (only a 10% failure rate, though 33% needed attention) because the man-made dams and pools provided marginal habitat that would permit juveniles of growing populations areas to survive.

The CSU Investigation of KNF Water Yield and Sedimentation 1992-1995

A bright side in Forest Service management in the past ten years was a contract that the Forest Service gave to Colorado State University (CSU) to conduct a study to validate the Water Yield Model and to investigate the relationship between sedimentation and timber harvest in streams on the KNF. This study was outside of the Forest Plan requirements

and indicates that KNF administrators realized as early as 1991 that the Forest Plan monitoring items were incapable of achieving their stated goals of predicting and validating timber harvest/beneficial use relationships (KNF 1993a). However, the CSU study, too, was unable to validate the R1-WATSED model, and it was unable to directly connect sedimentation with timber harvest activities through indices currently in use. However, this study remains important for its findings and suggestions from its investigation of 33 basins with at least eight years of flow data. This summation represents a direct scientific investigation of KNF watersheds and is one of only a handful of summary analyses produced on the hydrological functioning of KNF streams in the last ten years (see Table A-1.1 below).

Table A-1.1 Research Papers on the KNF, 1982-1997

Title of Paper	Author	Date	Scope
Interpretation of Kootenai National Forest Water Quality Data	S. Johnson	04/1982	Baseline summary 1960-1982
Water Yield Guidelines for Harvest of First and Second Order Drainages	S. Johnson & L. Meshew	12/1982	recommended max CCE % for small drainages
Habitat Rehabilitation Monitoring, Kootenai National Forest	R. D. Perkinson	/1989	summarizes restoration success
Yaak FEIS Monitoring, Aquatic Biology	R.D. Perkinson	03/1990	analyzes potential monitoring problems
Clarification of Forest Plan Water Yield Analysis Procedure	S. Johnson	03/1991	CSR and APFI relationships
Methodology for Riparian Inventory and Streamside Management Zone Delineation on the Kootenai National Forest	R. Pfister, K. Boggs, M. McCullough & R. Baldwin	1991	measured SMZ in twelve streams
Dodge Creek Fisheries Conditions	R. D. Perkinson	08/1992	instream assessment
Threshold of Concern for WATSED sediment increases	S. Wegner	10/1992	allowable 250% annual sediment increase & CSR
Headwater Channel Response to Harvesting on the KNF, Montana	H. Bojonell & A. Teclé	01/1993	sediment storage and LWD
Assessing Factors Contributing to Sediment Storage in Headwater Streams in NW Montana	H. Bojonell	05/1993	sediment storage and LWD in headwater creeks
Water Quality Status Report: Kootenay (Kootenai) River Basin, British Columbia, Montana and Idaho	K. Knudsen	1993	analyzes WQ data and methods on Kootenai River

Aquatic Ecosystem Inventory - Annual Progress Report	F. Mangum	1993	macroinvertebrate sample results - 1990-1993
Evaluation of Forest Fire Effects on Snowpack Accumulation and Melt in the Fourth of July Creek Drainage of Northwest Montana	B. Dodd	05/1995	fire effects and snowmelt rates
Aquatic/Riparian Ecosystem Habitat Survey	Watershed Consulting	11/1995	reference stream survey
Bristow Creek Water Resource Effects	S. Wegner	04/1996	summarizes years of Bristow Creek WQ monitoring
Canopy Effects on Snow Accumulation and Melt in Northwest Montana	J.B. Luce	05/1997	canopy effects between fire, cuts, and natural canopy
Validation of Water Yield Thresholds on the Kootenai National Forest	L. MacDonald E. Wohl & S. Madsen	01/1997	precipitation, flow, and sediment relationships

The major CSU findings (MacDonald et al. 1997) are listed in Appendix 6 for those wanting a more detailed summary of its technical findings. The study's conclusions can be summarized more simply, however. The study found four critical areas needing investigation: 1) water yield and streamflow indicators; 2) stream channel indicators; 3) reference areas and natural variation; and 4) flow and channel inter-relationships. The investigators concluded that streamflow classification more accurately reflects harvest effects than does stream channel classification but were unable to quantify either in a manner likely to resolve hydrologic debates over their relative merits in predicting timber harvest effects in the near future.

MacDonald et al. further concluded that sediment transport from mean monthly peak flows is more characteristic of problems than instantaneous high peak flow increases. When mean monthly peak water yields reach 6-8% more than normal or when sediment yields rise to 40-60% over normal (a ratio of 1:5), a qualitative change in channel stability occurs. This is a far cry from the KNF Forest Plan standard which allows PFIs of 12-20% and post-Forest Plan sedimentation increase allowances of 250% (Wegner 1992).

Percentage of exposed bank, pool infilling and pool substrate particle size, large woody

debris accumulation and sediment trapping rates are the best indices of harvest effects according to the CSU study.

While preferring to use quantitative monitoring of sediment storage processes as an index for timber harvest (hopefully it can someday reveal degradation before it occurs), the CSU investigators came down firmly on the side of encouraging qualitative investigation due to the current "inherent vagaries" of quantifiable monitoring and the "complexity of a quantitative cumulative effects model [which] precludes true validation." Perhaps, even to these scientific investigators, nothing is currently better than a person walking the stream to look for problems.

Conclusion

The CSU study reaffirms many points raised by the author over the years. Qualitative analysis needs to be taken seriously in identifying and tracking instream problems. Nothing at the time we begin Forest Plan Revisions, even quantitative analysis, can replace an investigator who takes his/her own eyes into the field to seek problem areas. Pool-infilling measurements are appropriate measures for identifying high levels of sediment transport, particularly when tied to large woody debris location analysis and pool particle size. Peak Flow Increase management at 14% PFI (the most common level on the KNF) is a risky practice, particularly when practiced on drainage after drainage instead of in rare cases. Sediment measurements remain critically important and must be designed to be effective through tightly planned scientific monitoring strategies.

When one combines CRG's long-standing concern over the lack of tracking riparian habitat components with its opposition to riparian harvests, it becomes increasingly clear that CRG has been pushing for a rational and scientific approach to water quality management since the mid-1980s. But more than that, CRG has urged a common sense approach to riparian management be accepted that ends blaming conservation for reduced timber harvests. Nothing can replace a person in the stream itself, assessing the problems as they arise, or analysts who track the problems effectively in a database and compare instream problems with those of reference reaches and with other managed areas. After ten more years of chasing the ASQ, it is time for the Forest Service to switch gears and to seek funding adequate monitoring and restoration work. It will need to assess watershed conditions and processes that will guarantee the beneficial uses of our streams. As monitoring illuminates limits to timber harvests, management policy must change to respect these limits. Restoration efforts not tied to timber sales are needed, both to provide jobs in the community and to re-establish quality habitat for endangered and sensitive fish species and aquatic life. Unsystematic, fragmented riparian monitoring did not work during the first ten years of the Forest Plan, and environmental groups should not allow the Forest Service to continue this approach in the next ten. Policy changes must be written into the Forest Plan Revisions, clarified so that all parties know what to expect in the coming second Forest Plan period.

TABLE A-1.1 - EXAMPLES OF SITE SPECIFIC MONITORING

Project	Monitoring Objectives	Monitoring Variables	Reporting Frequency	Findings
Alexander Cr. Unknown Year pre-Forest Plan	risk assessment for the protection of beneficial uses for a timber sale	past harvest, CSR, flood risk, ppt, soil, slope	pre-sale	Score of 24 - indicates moderate risk to beneficial uses (water supply, fisheries, spawning habitat)
Little Jackson Cr. Unknown Year pre-Forest Plan	risk assessment for the protection of beneficial uses (water supply, fisheries, spawning habitat)	past harvest, CST, flood risk, ppt, soil, slope	pre-sale	Score of 29 - indicates high risk to riparian beneficial uses
South Sullivan Clearcut Unknown year early Forest Plan	Watershed Restoration - reduced sediment yield into Sullivan Cr.; protect old roadbeds; reduce soil erosion in clearcut	- run-off examination to determine waterbar and sediment trap location; re-examine a year later; - check Sullivan Creek for siltation changes	file report on success of project or project updates - no date set	still awaiting report
Dodge Creek Habitat Loss pre-Reservoir (1950)	analyze potential loss of fishery habitat	spawning gravels	pre-dam report	lost to reservoir will be a "great loss" to stream with loss of 25 first class pools, 70 second class
Dodge Creek Fisheries Condition August 1992	- instream observations of WATSED outputs for timber sale - concern for sensitive cutthroat habitat	- high width/ratio from past activities and cattle - 50-60% fine sediments - high embeddedness - raw banks - few fish; poor pools; - LWD	pre-sale; no post sale monitoring planned	- watershed in serious and degraded conditions - riparian recovery slow - PFI (19%)/sediment relationship unclear - Dodge lone remaining intermediate. climate zone with westslope cutthroat -need aggressive recovery actions

Project	Monitoring Objectives	Monitoring Variables	Reporting Frequency	Findings
Young Creek Compartment 2 LP Salvage EA 1994	timber sale mitigation and modification	- Stream Temperature - Dissolved Oxygen - likely OK as most streams are being measured at 8 mg/l (limit = 5 mg/l) - sediment - WATSED modeling - % fines PFI - exceeded 1989-1995	pre-sale	1984 - 40% fines in spawning habitat CSR -two reaches poor RSI - 2 reaches unstable WATSED - 4 year predicted recovery from 1990 highs (188% of "baseline") - post-Forest Plan harvest further elevated fines 1989-93 - important cutthroat fisheries - temperature reaches harmful 55° in summer
Swamp-Edna 1989-1999	- BMP implementation and effectiveness - timber harvest effects	- peak flow - channel geometry - channel substrate - physical features - embeddedness - discontinued 1993 - fish population - water temp - discontinued 1993 - Rosgen hydraulic curves - introduced 1995	none specified - due 1997	- cattle destroyed Lake Creek station - restoration LWD filled with sediment and causing erosion - two additional sales added in meantime to area
Bristow Creek Water Resource Effects 1996	pre-salvage ecosystem analysis	- Streamflow regime - PFI must be < 12% - Water Quality -Channel Morphology - Groundwater	in-house pre-sale report	- need to relate TSS levels to fish; current peaks of short duration and not problematic to survival - poor correlation between WATSED sediment and core data - no expected effects from timber harvest - % fines measure up to 35%

Project	Monitoring Objectives	Monitoring Variables	Reporting Frequency	Findings
Yaak FEIS Monitoring - Cumulative Effect and Small Stations 1990	- long-term effects on fish and macroinvertebrates - quantify fish management to stream channel responses - validate KNF PFI model - WATBAL and CSR	- macroinvertebrate Biotic Condition Index - flow/discharge and channel morphology - Existing clearcut acres - WATBAL and CSR relationships aimed to validate model for 60-70% of forest (both subsequently dropped as models)	- yearly - 5 & 10 yr. substantial reports	no 5 year summary report made in 1996 for general monitoring or 316 monitoring
Camp-Everett Sale Bristow Cr. 1985 Plan - 1986-90 1992 - Review	- monitoring for fish habitat protection and reducing effects from expected peak flow increases from dying lodgepole effects program 1985-1992 - on-site to assess short-term sediment impacts, - off-site to assess long-term impacts on stability, sediment, spawning habitat	- Peak Flow levels - missed peak 1986-1989 - bedload and discharge - BMPs 1985 Monitoring Plan - sediment cores - redd counts - add sediment traps to Camp and Hickey Cr. - photo points and channel stability reevaluation - periodic CSRs - not done every 5 yrs - annual survey of LWD to judge natural variation	analysis as done and at monitoring termination (w/in 6 mos.) - still awaiting final analysis to answer identified questions-year 2000	1985 - suggests debris <i>removal</i> program to improve pools - failed to measure peak events - failed to monitor culvert <u>before installation</u> - roadbuilding mobilized sediment even at low flows - sediment recovery in 4-5 yrs - NTU 1.5 - 23 - NTU (culvert site) 3.2 - 84 1989 - initiated protective measures on culvert - Bristow Cr. is "high risk" creek based on past activities 1985 - proposed PFI of 14-18%

Project	Monitoring Objectives	Monitoring Variables	Reporting Frequency	Findings
<p>Arbo Creek</p> <p>1992</p> <p>estimated cost: \$39,621</p>	<p>Assess fire salvage opportunities and impact on watershed</p>	<p>Mitigation monitoring</p> <ul style="list-style-type: none"> - post- harvest road patrols - LWD and shading target success <p>Water Quality Monitoring</p> <ul style="list-style-type: none"> - BMPs implementation (Form 2) and effectiveness (Form 3) - validation monitoring <ul style="list-style-type: none"> - erosion and deposition - fill and scour distribution - particle size and X-section - part. size, transects - blowdown and bank stability - none listed - low and peak flow changes - annual peak and low - road erosion - none listed - survey NPS pollution (state) - BMPs, NTUs (ISCO) - Water Temp (state) - <p>Research</p> <ul style="list-style-type: none"> - Snowpack depth and Snow Water Equivalent by University of Montana 	<p>in-house reports by Dec. 1 of each year monitored</p>	<p>- no results - still awaiting all reports</p>
<p>Big Creek Monitoring</p>	<p>fish/sediment</p>	<p>- temperature, W/D ratios, X-sections</p>	<p>5 & 10 year summary reports</p>	<p>no reports issued</p>
<p>Compartment 26 Salvage</p> <p>1992</p>	<p>identify areas of concern</p>	<p>Water Quality - BMPs; no instream monitoring; WATSED prediction for recovery to geomorphic threshold within two years in all drainages</p> <p>Streamflow regime - PFI predictions within 14%</p> <p>Stream Channel Morphology - no F-Plan standards</p>	<p>none</p>	<p>- predicted no-action recovery of few years</p> <p>- no in-field monitoring required</p>

Project	Monitoring Objectives	Monitoring Variables	Reporting Frequency	Findings
East Fortine Timber Sale FEIS 1991	protect beneficial uses	BMP monitoring increased turbidity and sedimentation - 3 stations - X-section, - longitudinal section - channel substrate - core samples - fish populations	yearly in-service reports; 5 and 10 year summaries	awaiting five year report
4th of July Salvage EA 1992	to determine if resource objectives were met and determine long-term recovery trends in 4th of July and Cyclone Creeks	BMPs (Forms 2 + 3) Validation monitoring - erosion and deposition - fill and scour volumes - particle size, X-sections - - blowdown and bank stability (none listed) - low and peak flows (Cyclone Cr.) - road erosion (none listed) - survey NPS (state) - turbidity (ISCO, visual) - Water Temp - automatic samples (Cyclone Cr.) Research - Snowpack depth and SWE	in-service reports by Dec. 1 of each year	still awaiting all reports
Lost Soul Salvage 1993	judge effects of proposed salvage on watershed	Water quality - % above baseline Streamflow - % above baseline Channel Morphology - none	no in-field monitoring projected	
Wolf Davis EA 1991		PFI - harvest only in those below 14%	no in-field monitoring	Weigel already 17%

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APPENDIX 2 Methodology as a Participant Observer

Forest Watch Activism as a Means to Change Policy

Following a general introduction on public/governmental agency interaction roles, this appendix explores the involvement with water quality issues by both the author and the Cabinet Resource Group (CRG) during the ten years the Forest Plan has been in effect. The Cabinet Resource Group is a local environmental organization which has supported water quality conservation in natural resource debates in northwestern Montana since 1978. In particular, CRG twice opposed dam construction on the Kootenai River, fought legal battles to prevent mine tailings leaching into premium trout fishing streams, and worked to improve water quality monitoring and alternative practices to prevent the flow of sediments into streams from timber harvesting. In the following discussion, each occurrence is given short but detailed attention in order to illustrate the continuity of CRG's positions through the years and the effectiveness it had in influencing policies during the first four years of Forest Plan implementation. Each section also includes a brief discussion of issues involved with each interaction as a means of introducing a wider view towards the issues of riparian habitat monitoring and to illustrate that many of the changes just now taking place under INFISH and the Interior Columbia Basin Ecosystem Management Project (ICBEMP) have always been essential parts of CRG's water quality protection program since the mid-1980s. Following 1991, however, relationships soured between CRG and the Forest Service, indicative of increased adversarial relationships between environmentalists and both state and federal agencies over natural resource use and wildland protection. Since then, few changes have been implemented in Kootenai

National Forest (KNF) management policies as a result of local participation in NEPA processes or through field trips and meetings.

Environmental Sociology Looks at Public Participation

Public participation in forest management issues, often called Forest Watch by environmentalists, has multi-dimensional functions for both the agency and activists. In an ideal "democratic" sense, public input is a cornerstone of the National Environmental Policy Act (NEPA) aimed at guaranteeing the right of citizens to have input into the management policies of its governing agencies. First and foremost, without the *willing and welcome* participation of citizens in policy decision development, there can be no means for the government to address the concerns of its citizenry on environmental issues. Thus NEPA success demands both attentiveness on the part of agencies to citizen concern and the development of active roles for the public in the decision-making process, a process "guaranteed" through the National Forest Management Act (NFMA) and Forest Plan strategies. However, without the effort by citizens to overstep the legal framework and to interject themselves directly into the daily affairs and management of the forests, the right bestowed to the public in NEPA is often one of form rather than substance as evidenced by the history given below.

Attentiveness to public concerns gives the management agency legitimacy to carry out management policies in the wake of public conflict over natural resource use and protection. By balancing conservation (sustainable use of resources) with the protection of natural processes and biological communities, the Forest Service promotes an image of

itself as fair and honest managers capable of implementing scientific management based on multiple use forest management strategies that include elements of diverse public opinions. As long as Forest Service positions are integrative, i.e. make sense to divided cultural groups *from the perspectives of their individually-held cultural values* (Habermas in Seidman 1989), the Forest Service maintains the legitimacy to monitor itself and its work. But two key elements have interfered with Forest Service legitimacy in the past decade that have injured its legitimacy and its ability to manage as non-aligned resource managers: lack of scientific credibility and the management of forest resources for single client benefits - the timber industry through output-driven policies.

The scientific credibility issue was first raised by what I call "anonymous environmentalism," a cultural belief which was born at the turn of century but grew to prominence in the 1970s. This belief holds that over-use of natural resources by expanding populations and modern industrial-capitalist demand will cause society to approach the carrying capacity and environmental limitations of natural ecosystems, forcing subsequent social adjustments in use, management policies, and institutional structures involved in natural resources (Ehrlich and Ehrlich 1970; Dunlap and Catton 1978; Buttel 1992; Catton 1994). From the late 1970s, scientific investigators began to echo fears about the real environmental limitations of forest ecosystems (OGDTG 1986; Maser 1988; Noss 1989) and evidence that the Forest Service was disregarding scientific evidence concerning the degradation of forest ecosystem health appeared from within (AFSEEE 1990) and without (Manning 1991). On the Kootenai National Forest, two biologists went public with statements that the Forest Service was rewriting biologists

opinions (Synar Committee Hearings, U.S. Congress 1991) and presenting harvesting plans in which it would be impossible to meet biological objectives (CNN 1991). The bureaucratic tendency to suppress internal scientific dissent and to mold scientific findings to meet output objectives, analyzed by environmental sociologists (Schnaiburg 1977; Schnaiberg and Gould 1994) as a particular form of *bureaucratic slippage*,¹ led environmentalists from the mid-1980s on to begin to offer independent analysis and policy suggestions outside the scope of normal Forest Service institutional practices and legal requirements. Nationally and regionally, those suggestions included the proposal to manage the Northern Rockies Ecosystem for recovery objectives rather than output objectives (AWA 1991), the adoption of watershed ecosystem analysis (PACFISH 1992 and INFISH 1994), and the gradual adoption of agency acceptance of ecosystem management on the grandiose scale of the ICBEMP. Locally, independent analysis and demand for institutional change included the Cabinet Resource Group/Montana Wilderness Association appeal of the KNF Forest Plan, the Grizzly Bear Citizens Advisory Board, the environmental-labor coalition known as the Kootenai Accords which recommended the protection of most of the roadless lands left on the KNF, and this author's citizen-generated Alternative 10 in the Upper Yaak FEIS (KNF 1990).

The second loss of legitimacy, that of supporting output objectives of a single clientele - the timber industry - over environmental protection and multiple use management has hurt the Forest Service with both environmentalists and timber communities. Independent

¹ *Bureaucratic slippage* is defined as the tendency of agencies to acknowledge stiff environmental protection in its mission statements and under its legal obligations while it slowly undermines the intent through its regulations and implementation policies which often are not open to public review and legal criticism (Freudenburg and Gramling 1992).

research by environmentalists showed that old growth on the KNF was being cut rather than protected to Forest Plan standards and that the Forest Plan Allowable Sale Quantity (ASQ) was based on the existence of mature stands that had already been harvested - the infamous "phantom trees" (Sedler et al. 1991; Federal Register 11/95). Environmentalists countered claims that timber harvests were down due to timber sale appeals (KNF 1993a; KNF 1997) with a report showing that timber harvest trends followed national markets and profitability and were only in part due to environmental restrictions (Clark 1996). Meanwhile, a body of literature arose showing that timber communities were suffering dramatic social upheavals due to timber harvest declines, industrial restructuring, and environmental protections (Le Master and Beuter 1989; Lee 1994). Others pointed out that so-called single resource communities were, in fact, diverse communities that often rebounded from temporary dislocations (Bailey et al. 1993; Freudenburg 1992; Clark 1994).

This discussion on scientific legitimacy provides the background for the following description of the CRG's roles in water quality issues on the KNF over the last ten years. Far from offering legitimacy to the Forest Service and its management, this segment describes a yet unresolved conflict. CRG continues to insist that institutional changes are needed that elevate the power of citizen oversight organizations in Forest Service decision-making. Without strong citizen oversight, failures evident in KNF riparian and aquatic habitat monitoring will continue. Forest Service management on the Kootenai National Forest still does not fall within the sensibilities of the cultural values of the Cabinet Resource Group. Until the proposed changes included within this report are

adopted, it is highly unlikely that sharp conflicts over water quality and riparian issues will be resolved between CRG and the Forest Service.

The Forest Plan Appeal Revisited

The Cabinet Resource Group/Montana Wilderness Association appeal of the 1987 KNF Forest Plan has already been mentioned, but its major points should be recapped since the appeal was upheld in 1995 and the Kootenai National Forest directed to begin a Forest Plan Revision this year. The CRG/MWA appeal included complaints against many points related to the nine factors delineated in the plan to monitor riparian habitat and components (see below). However, the National Office decision to remit the appeal to the Region for a Forest Plan Revision did not specifically list any of the water quality objections as reasons for upholding the appeal.

The Forest Plan Appeal Complaints

- 1) Develop a separate and distinct Management Area for riparian;
- 2) Allow no timber harvesting in riparian areas;
- 3) Provide corridors to lessen the fragmentation of old growth stands;
- 4) Disallow firewood gathering in all old growth areas;
- 5) Use clearcutting only when proven "optimum,"² given all multiple use values;
- 6) Remove from the timber base erosive landtypes above critical fisheries streams;
- 7) Adopt American Fisheries Society Best Management Practices;

² *Optimum* is a word used by the Forest Service as a standard to decide on whether clear cutting or alternative harvesting methods will be employed. However, its vagueness allows agency discretion and resulted in a harvest almost exclusively composed of clearcuts during the first five years of the Forest Plan implementation. Between 1987-1992, the only non-fire salvage harvest not clearcuts were negotiated by CRG through appeals with the Forest Service (KNF 1989) and in negotiations over the Upper Yaak 316 Sales.

- 8) Condition funding of timber harvest on prior funding grants for mitigation and monitoring;
- 9) Prepare a Forest Plan alternative that maintains fisheries;
- 10) Prepare an EIS with an adequate, full and fair discussion of a) effectiveness of mitigation measures, b) cumulative effects of open and closed roads on fish and wildlife;
- 11) Define how additional environmental analysis required prior to making recommendations on mineral and oil and gas lease application will be used;
- 12) Acknowledge Montana Water Quality Act's nondegradation policy;
- 13) Allow no timber harvesting or road construction that would violate the Montana Water Quality Act's nondegradation policy;
- 14) Design and implement an effective water quality monitoring plan capable of determining if the Montana Water Quality Act is violated;
- 15) Monitor for water quality impacts before, during, and after the life of an action;
- 16) Provide biannual water quality monitoring reports; and
- 17) If monitoring for water quality shows a violation of the Montana Water Quality Act's nondegradation policy, cease the action and reevaluate the Plan.

The appeal went on to highlight the Forest Plan's modeling that clearly predicted declines in fish population contrary to the Montana Water Quality Act's clause that conservation meant "maintaining and improving the quality and potability for wildlife, fish, aquatic life ... and other beneficial uses" (MCA 75-5-101). The appeal stated that BMPs, while beneficial, are not guarantees of water quality protection. During the ten years, items #7, #12, #16, and at times #17 have clearly been implemented. Items #2, #3, #4, #6, #8, #9, and #14 have not been implemented. The others have to some extent, often depending on the viewpoint of the observer.

One other criticism raised was, "Rarely, if ever, can timber harvesting 'improve' riparian habitat." (CRG/MWA 1987:4) This thread of thought runs throughout CRG's ten years of testimony and practice and may be said to serve as the root ideology of the organization's water protection practice. Arguments against this principle, found throughout timber sale EAs on the KNF, generally state that under Forest Service management procedures and funding, timber sale receipts can improve habitat by collecting funds that 1) reconstruct old sub-standard roadbeds and crossings to meet BMP standards, 2) reduce revegetation time by salvaging and then planting seedlings, 3) support stream restoration projects in the project area, and 4) support in-stream monitoring during the life of the project (KNF 1996a). The semantics of "maintain and improve" become muddled when the habitat is already in degraded or deteriorating condition from past management practices. On the KNF, past harvesting habits such as riparian clearcutting, the clearing miles of instream large woody debris, and high densities of road stream crossings muddle management objectives and its ability to assess degradation levels from continued harvesting.

Forest Watch Protection for Riparian Habitat

The author began his role as a participant observer of riparian events in the fall of 1988. Following nineteen days on the firecrew on the Dry Fork Fire (Canoe Gulch District), I wrote a letter complaining about thermal cover losses and snag and instream woody debris removal in Canyon Creek as part of the fire suppression effort, pointing out that a 40 foot-wide roadway for a firebreak already existed just above the creekbed. The Forest

Service replied that 1) fire suppression demanded more critical attention at the time and 2) that a post-fire assessment had revealed that several instream structures were removed and that a dozer had entered and rechanneled about 40 yards of the cutthroat spawning stream during the fire suppression. The Forest Service and state worked together in assessing the damage and developed a restoration project that included rebuilding stream structures, revegetation, and replanting (Froberg 1988). In response to my letter, they also agreed to leave extra snags throughout the fire area and initiated the only snag survival study done on the KNF during the first seven years of the Forest Plan. This was an excellent example of rapid response to a short-term duration disturbance through remedial restoration activities. It also was a good example of public-Forest Service interactions and the promotion of site specific scientific monitoring (snags) that can come from them.

The author represented the Cabinet Resource Group in the 1988 Swamp-Edna Timber Sale Appeal (Fortine District), appealed at the request of local citizens in the area and filed jointly with American Wildlands Association (AWA) of Bozeman. Rick Hildebrand, Jim Bremer, and the author established a working negotiating team that analyzed the aerial photographs and project records, met with the Supervisors Office hydrologist and state fisheries representatives, and went on numerous field trips to the area before, during, and after the sale completion. Field trips with Fortine District representatives and Larry Brown of the Department of State Lands Water Quality Division established that riparian harvests in the area were violating state water quality standards and KNF Forest Plan guidelines for the following reasons:

SMZ Violations, Swamp-Edna Appeal

- 1) riparian widths of less than 100 feet violated streamside management zone (SMZ) widths in Forest Plan;
- 2) not enough trees and vegetation were being left for instream temperature regulation and adequate riparian plant shade protection;
- 3) small diameter green trees and streamside vegetation were not being protected as upland sediment transport interceptors and buffers;
- 4) Streamside Management Zones (SMZs) were not marked clearly and often did not extend to the full width of obvious wetplant habitation; and
- 5) channel cutting and lack of LWD was likely a result of recent cutting practices and elevated PFIs, making more recruitment trees needed.

As a result of the negotiations, the *first site specific water quality monitoring plan under the KNF Forest Plan* was established following the recommendations of the state inspector. The Fortine District secured funding assurances from the Regional Office to set up a ten-year plan with five monitoring stations (Sterling, Lake, Fortine, Edna, and Swamp Creeks). Nine parameters were to be measured (peak flow, channel geometry, long profile, channel substrate, physical features, embeddedness, photo points, and water temperature). Not all parameters were to be measured at each point and most were to be measured every year or every other year. Later, Rosgen classifications and calculations were added to the process (Bohn and Muhfield 1997). Other than an earlier monitoring program at Camp-Everett on the Canoe Gulch District (1985-1990), this has been the only sustained timber sale/riparian habitat effects monitoring on the Kootenai National Forest since 1985 and it was initiated by the Cabinet Resource Group, not the Forest Plan.

A full-scale summary assessment of the results, to be used in the Forest Plan Revisions, is currently underway. *A draft of the summary, provided for the project file for the Ecology Center monitoring lawsuit of 1996, shows many gaps in monitoring and includes several summaries of problems and concerns stemming from the monitoring. A similar document received under the Freedom of Information Act for this paper in May, 1997, has the blanks in the database filled in and problems areas omitted.*³ Unexplained "corrections" such as these continue to raise doubts about the honesty of Forest Service database assessments. No mention in the Swamp-Edna assessment is made of large sediment flows that actually lifted the Lake Creek crest gauge out of the water or the cattle that trampled one of the monitoring stations. *The Lake Creek gauge was actually moved after the first two years, making the early data meaningless.* Losing key information appears a troubling problem within Forest Service database entries and harms its reporting accuracy.

Other important negotiated parts of the settlement included expanded riparian zones, no cutting of recruitment trees leaning towards the creeks (i.e. future LWD), selective riparian harvest but no mechanical entry into riparian zones, and the leaving of green trees and riparian vegetation in riparian zones. Respecting riparian integrity, components and

³ "Several high stage checkdams (approximately eight) were installed along Sterling Creek in 1989... Although these were installed prior to the Settlement of Agreement [actually during negotiations], it is worth noting that a majority of these structures have failed to serve their purpose..." The Monitoring Report summary goes on to explain that the structures back-filled with sediments, decreasing sediment transport and channel depth, and leading to an increase in bankfull channel width. "In general, streams within the Swamp-Edna physiographic area are deficient in large, woody debris. Riparian harvest and removal of woody debris from the active channel and streambanks has destabilized many reaches throughout the Swamp and Edna Creek watersheds. In addition, existing structures constructed since the late 1980s have caused some degree of channel alteration that has inhibited the stable morphology and function of the channel. Due to the lack of recruitable material from streamside areas, a short-term plan to introduce material to the stream is recommended." (Item #L-28, Project File 97, KNF Monitoring Lawsuit 1997)

processes was not established procedure under the KNF Forest Plan, and it was the direct intervention by CRG that led to the implementation of stricter infield procedures. The cost in time and wages lost to participate in the process was high and borne by the individuals involved, not by the underfunded CRG.

Whether the Forest Service monitored the implementation or success of these alternative practices has not been reported. In fact, CRG has received no report or analysis of the conditions at Swamp-Edna since the agreement. Representatives of appellants were supposed to be allowed to participate in IDTeams in the area, though the District unilaterally restricted this to participation in infield examinations and not team meetings (where analysis occurs). In the end, CRG did not have the financial resources to send personnel to the field to monitor the sale progress and, in spite of finding many early violations during the first two years of implementation, CRG cannot independently analyze results of its involvement at Swamp-Edna. This lack of follow-up and inability to participate legally in the process itself is a direct contributor towards bureaucratic slippage.

The Swamp-Edna Settlement Agreement marked the only successful negotiation between the Cabinet Resource Group and the Forest Service on water quality monitoring. Afterwards, negotiations were limited to withdrawing proposed sale units during Environmental Assessments rather than establishing effective monitoring procedures. As the Forest Plan Revisions approach, it is ironic that the Swamp-Edna Monitoring Program, initiated by CRG, may be the KNF's only validation monitoring for many of its Forest Plan parameters.

The Upper Yaak FEIS and the 4th of July Burn

The author participated in two environmental analyses in the early Forest Plan years in an effort to improve KNF project implementation towards better riparian management.

The Upper Yaak FEIS of a 694,000 acre area in the KNF along the Canadian border was the first attempt at ecosystem analysis done on the forest - a response to a lawsuit by the Save the Yaak Committee. CRG contested Forest Service timber harvest plans by jointly supporting Alternative 4, which severely limited timber harvests due to water quality maximization, and Alternative 10, my independent alternative, which supported water quality protection indirectly through: 1) selection harvest and lodgepole-only salvage; 2) snowroads and winter harvesting; 3) temporary roads built high above streambeds; 4) helicopter logging; 5) no harvesting in riparian areas; and 6) removing stream crossings. None of these practices were widely used on the KNF in 1988. However, following the submission of Alternative 10, the KNF and the Montana Water Quality Bureau reached a Memorandum of Understanding that changed the water quality standards on the KNF to be implemented, specifically that the forest had to stay within its predicted allowable peak flow increase limits established by its water yield model. The Forest Service then refused to allow the author to change his alternative to meet the standards and then rejected

Alternative 10 on its failure to meet the new water quality standards.⁴ Since then, the

⁴ Actually, the Upper Yaak ROD rejected Alternative 10 on the basis of its failure to meet water quality standards and grizzly bear standards - both changed after Alternative 10 was submitted. Even when the author demanded to be allowed to adjust them for fear of having the many innovative ideas rejected out of hand (selection harvest, lodgepole salvage, winter logging, national recreation trail viewshed protection, elk corridor protection, increased snag protection through clumping and forested leave islands), the Forest Service refused. Later, the alternative was rejected with not a single word directed towards the validity of any of the innovative ideas. The Forest Service analysis also stated that Alternative 10 planned two-sided riparian harvest when, in fact, it opposed all riparian clearcutting. Alternative 10 did permit riparian salvage which is still permitted even under the far more restrictive INFISH standards implemented only one year ago.

Forest Service re-entered portions of the Upper Yaak already out of compliance (Porcupine Creek and Basin Creek) and are currently proposing further reentry into Basin Creek.

It is significant to note that the permanent road built into the East Fork of Basin Creek in the Upper Yaak was proposed as a temporary road by Alternative 10. The road's streamcrossing of the tributary to the East Fork, opposed by environmentalists and built under the most modern BMPs, has since eroded, passing enough sediment into the tributary to make it unsuitable for spawning and rearing of the drainage's native redband trout, a sensitive species found in only four watersheds in Montana (KNF 1996a). This example represents the opposite of Swamp-Edna situation - a disregard for public input and the inability to continue site monitoring beyond the timber sale itself. Furthermore, it is a sad but clear example of modern BMPs being unable to prevent clearcut degradation of beneficial uses. In later years, increased winter logging and lodgepole salvage were adopted by the KNF to meet wildlife restrictions and as part of its watershed management.

The lower Yaak River drainage suffered a catastrophic fire in October of 1991 when several Forest Service burn piles were not extinguished, even in one of the KNF's deepest drought years. High winds exploded the flames into a nearly 12,000 acre burn that fried the old growth-dominated 4th of July drainage and the second-growth Cyclone and Arbo Creek drainages. Parts of the Red Top watershed (a KNF Forest Plan and USGS reference watershed that had just been roaded) were also burned, leading to large harvests within it and the loss of one of the Kootenai's few remaining reference streams. In order to comment, the author requested, through the Freedom of Information Act, watershed

surveys in the area which showed pre-fire problems in 4th of July from roadbuilding and bank sloughing. Based upon this and the Forest Service's proposed monitoring program in the EIS, the author offered the following criticisms and alternatives to the monitoring plan (Clark 1993).

Suggested Monitoring Changes, 4th of July Creek

- 1) The Forest Service should commit to several immediate adjustments in its practices including: (a) prompt submittal of yearly reports, including evaluation of monitoring data, field problems, and suggested adjustments for public review each December; (b) a commitment to long-term monitoring of key parameters;
- 2) Fish surveys should be done yearly for at least 5 years to determine the actual effects that post-fire consequences are having on fish populations;
- 3) Fish habitat should be assessed through core samples (preferably within identified fish redds), through the measurement of interstitial dissolved oxygen levels in redd and streambed gravels, through redd counts during appropriate spawning periods, and through long-term pool infilling assessments;
- 4) Pool infilling assessments require: stream reach surveys to determine appropriate pools to measure; measurement of depth/time and volume/time to determine sediment buildup in key winter habitat; and measurement for a long enough duration to assess sediment effects from latent soil creep;
- 5) Yearly stream reach surveys to check on problem points in the riparian zones that may need immediate remedial attention;
- 6) Continuance of turbidity and TSS testing tied to flow monitoring, especially important during rising and falling of spring peak flows. This data is essential for cross-forest

comparison as it is the most commonly used technique currently employed on the KNF by the various districts;

- 7) Use and evaluation of RASI monitoring for the next 5 years; and
- 8) Computer analysis of cross sectional changes for flow and bedload movement analysis.

The results of the 4th of July Burn monitoring have never been reported to the public, and no response to the author's comments was ever received. In the spring of 1993, the TSS level of 4th of July Creek reached 1624 mg/l, an almost unimaginable level except that the same year, Granite Creek, a USGS station on a stream from the Cabinet Wilderness Area registered even higher, leading the Forest Service to gloss over the high 4th of July suspended sediment level as "within the range of natural variation." In 1994, the Intermountain Research Station in Moscow, Idaho, was contracted to study peak flow levels from unharvested and harvested areas within the burn, a three-year study whose final report was released in May of 1997. The report states that increased peak flows from rain on snow events come from harvested and burned areas both and that spring high flows come earlier and last longer but are not significantly higher than those from non-harvested areas. These studies imply that proposed harvests of dead lodgepole in other areas, planned for the coming year on the KNF, will increase volume and duration cycles from rain on snow and spring melt events by opening the canopy.

Other Water Quality Involvement

Water Quality regulations, both on the forest and in the state, have been changing throughout the ten years of Forest Plan implementation. In 1990 the KNF Riparian

Guideline committee redefined the Forest Plan Riparian Guidelines through Amendment 26 to the Forest Plan. This established Streamside Management Zones (streamside buffer zones), 100 feet alongside perennial streams and 50 feet wide around intermittent streams. The author presented comments in favor of increasing leave tree retention levels to protect both integrity and effective width of riparian areas. In 1993, the Montana Legislature held hearings on proposed changes to the Water Quality Act, and the author submitted written criticism against the weakening of the definition of non-source pollution as regards forestry practices and sedimentation levels. Unfortunately, the law was rewritten to say that if BMPs were used, the resulting sedimentation increases from the harvesting activity could not be called degradation. When the state Streamside Management Zone Law (HB731) was proposed, the author testified both in Missoula and Kalispell because proposed changes to narrow the SMZ to 50 feet along perennial streams would halve the width of SMZs on the KNF. The requirement to leave one live tree every ten feet was also opposed as incapable of supporting riparian animals and aquatic habitat. The author contested the statements of Larry Brown specifically who, now working for Plum Creek, was supporting narrow riparian widths that he opposed previously as state a state water quality inspector at Swamp-Edna. A year later the KNF adopted the weaker state regulations by amendment and began issuing timber sales with 50 foot-wide riparian zones. However, increased restrictions against mechanical use in riparian zones led the KNF management to report somewhat falsely that:

"There has been less harvesting in riparian areas as a result of the Riparian Area Guidelines (FP Appendix 26) and the Montana Streamside Protection Act. The effect on ASQ achievement is about 5% or about 10 MMBF per year." (KNF 1993a)

It is difficult to accept such a statement as a valid Monitoring Plan assessment - where are the criticisms of a Forest Plan which failed to account for the protection of riparian areas in the first place and for those who, against strong objection by environmentalists, failed to account for subsequent required declines in the ASQ? The Forest Service continues to measure its monitoring success in terms of parameters that were improperly designed, blaming environmental regulations for timber declines rather than their own miscalculations - a means to validate and legitimize their continued close relations with the timber industry.

The author represented CRG on the Kootenai River Network, a working group of Forest Service employees from the KNF and the Idaho Panhandle NF, the state water quality bureaus of Idaho and Montana, the British Columbia Ministry of the Environment, the Kootenai Tribe of Idaho and the Kootenay Bands of Creston and Cranbrook, CRG, and various environmental and sportsmen groups in Canada. The purpose of the group was to consolidate known water quality data on the Kootenai River Drainage, discuss monitoring techniques and results, and possibly propose standardization of monitoring methodology in hopes of developing an international approach to water quality monitoring. A summary of the history of water quality monitoring on the Kootenai River was produced (Knudsen 1993). The Kootenai River Network (KRN) was organized by CRG initially and funded by grants through the Montana Water Quality Bureau. The

group put on an Adopt-A-Stream workshop attended by the author and began an Adopt-A-Stream program that now operates independently of the Kootenai River Network.

Mining Issues

This paper does not directly analyze mine and mine tailings pollution on the Kootenai in order to maintain a scope centered on monitoring responsibilities under the KNF Forest Plan, even though CRG's work on this issue is almost legendary in the state of Montana. The Water Quality Bureau, not the KNF, has the responsibility to monitor for chemical pollution below mine adits and tailings ponds. However, within the scope of this paper's discussion of sedimentation and riparian habitat were the author's comments submitted against the Noranda Mine as part of the Ecology Center's comments to the Montanore EIS. Citing ample references to sedimentation problems for bull trout spawning grounds and tailed frogs, the author criticized the proposed monitoring program. The chief question I asked was why the EIS failed to address the issue of sediment transport and erosion from the earthen pile to be stockpiled for 16 years for re-covering the tailings impoundment - a pile the size of a Chicago city block seven stories high and not even mentioned in sediment sections of the document. No response was received.

The Water Quality Mapping Project

Finally, the author secured funding from the Patagonia Foundation and then the Norcross Wildlife Foundation to attempt to collect and map the water quality data on the

Kootenai National Forest. That study, begun in 1993, is incorporated into this report for the Cabinet Resource Group as Appendix 4. It includes water quality GIS maps which were made with the assistance of Conservation Imaging of Moscow, Idaho, and the Ecology Center in Missoula, Montana. These maps were constructed with information received through six FOIAs dispersed over five years, meetings with Supervisor Office hydrologists and with fisheries biologists and hydrologists on the Three Rivers District, Canoe Gulch District, Fortine District, and Rexford District.

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APPENDIX 3: Part I**What Trends Are Being Encouraged for Future Monitoring?***The Cart before the Horse - Monitoring without Strategy*

Any report on the KNF riparian habitat conditions and monitoring must turn its attention to seeking a better methodology for future KNF riparian monitoring. This report has presented the view that Forest Plan monitoring has been unable to demonstrate the protection of beneficial uses due to four inadequacies: (1) a lack of an overriding commitment and defined scientifically-based strategy to protect riparian habitat; (2) the lack of a defined methodology to examine the current condition of watersheds; (3) the use of monitoring practices inherently incapable of validating the models underlying Forest Plan goals and objectives of protecting beneficial uses; and (4) an inability or unwillingness to make analytical and summary analysis of monitoring results. This appendix focuses on the first three of these problems - strategy, methodology, and validation - by recognizing that they are highly related. They are not independent of each other because of managerial constraints (budgets, time commitments, and research capabilities) and constantly evolving hydrologic theory and monitoring strategy. Constraints limit what management can achieve in a given period of time, and scientific evolution changes the parameters to be measured and the methodology to measure them in mid-stream, making the commitment of constrained agency resources even more difficult to prescribe.

This appendix introduces in more detail four main documents that have direct bearing on the future of watershed and riparian habitat management on the Kootenai National Forest. The first is the Columbia River EIS project document, Status of the Interior

Columbia River Basin: Summary of Scientific Findings, will determine the role of watershed management in the over-riding ecosystem management strategy that should guide Forest Service macro-strategies for the next ten years. The Forest Service was a reluctant participant in ecosystem management during the first half of the last ten year cycle, coming out of a period of historically high timber targets and a demonstrated lack of wildlife habitat constraints. Forest Plan implementation clearly forced the issue of conflict between timber harvest practices and habitat protection, opening the gate for public opposition to and scientific demands on the agency's management policies. Post-Forest Plan work by the Cabinet Resource Group emphasized deficiencies in Forest Plan riparian and monitoring strategies and practices in an effort to increase local input into management processes (CRG/MWA 1987; KNF 1990b; KNF 1990c; Clark 1991). Now ecosystem management promises guidelines coming from an even more remote governmental body which is developing strategies on a macro-ecosystem scale. How protection of the Columbia River Basin will relate to individual watersheds on the KNF and whether local opposition will have less impact will be a function of the Forest Plan Revisions soon to be prepared throughout the region.

The second document has already been examined in detail - the 1996 KNF Monitoring Report. It offers suggestions about changes in the monitoring items under the revised Forest Plan. But the 1996 Monitoring Report does not propose changes in the underlying monitoring strategy which the author feels are necessary to redirect the monitoring program towards increased effectiveness and validation.

The third report covers proposals under the interim Inland Native Fish Strategy (INFISH) which will largely be incorporated into the wider Columbia River Basin EIS. INFISH represents a radical reversal of Forest Plan assumptions that riparian zones do not need a management strategy of their own in order to protect riparian and aquatic habitats and their ecosystem functions. INFISH protects riparian zones and buffer areas under the strategic assumption that the *need for maximum protection of riparian resources already exists*. Modeling riparian components and validation monitoring of the models are not discouraged, but protection and restoration are raised as objectives regardless of validation success.

Finally, I wish to return to recommendations in the 1993-1995 Colorado State University study, "Validation of Water Yield Thresholds on the Kootenai National Forest," which purported to investigate the relationship between management harvest activities on peak flow increases and water yields and subsequent sedimentation effects that directly affect instream beneficial uses, primarily fish habitat. The study's "inconclusive" conclusions have profound meaning for developing the next ten year's Forest Plan's Goals and Objectives and monitoring strategy. As the only existent summary on forest-wide watershed comparisons and one of four research assessments on the effects of KNF timber harvest on riparian relationships, this document necessarily must be considered the state of the art baseline data analysis today and its recommendations need to be addressed.

A second subject of this appendix is a criticism of the monitoring practices discovered during Freedom of Information Act searches into field practices and monitoring results

during the last ten years. These are offered as Forest Plan Revision comments with due respect given to my hydrologist friends on the KNF. These technical criticisms are given in hopes of assisting them in generating better and more consistent field data.

Strategies for Managing and Monitoring Nested Riparian Ecosystems

Because riparian ecosystem degradation is caused, on the one hand, by an accumulation of small, site specific events and, on the other, by a cumulative effect from broad water yield increases, it remains exceedingly difficult to make managerial decisions which protect some ecosystem resources while manipulating others for timber extraction. The trend in forest management has been to analyze areas in terms of broader relationships known as ecosystems while controlling for problems through site specific BMP implementation under the guidance of generalized water yield and sedimentation models. Neither require direct instream monitoring. Ecosystems, defined as a set of operational relationships in equilibrium between plant and animal communities in a given bounded geophysical space, are *nested* in that any given ecosystem is inherently part of both larger and smaller ones. The boundaries of an ecosystem are arbitrarily defined by the observer based upon what parameters are being observed. Riparian ecosystems, the land at the edge of wetlands, lakes and streams, are related both to the wider forested landscape - the watershed - and to the aquatic ecosystem. Riparian areas are critical to forest management in both relational directions - as buffers against potentially negative influences outside the stream (excess sedimentation, overland flows, and sunlight) and as corridors for needed outside influences to reach aquatic habitat (animals, nutrients, and energy in the form of leaf litter).

Furthermore, riparian areas have components inherent only to them (pools, fish, aquatic insects, wetland plant communities) and components found in other areas but which take on special riparian functions (recruitment trees and instream LWD, nesting sites for water pipits).

KNF management policy has never clearly defined riparian ecosystems and, therefore, has not been able to establish strategies for defining their presence (e.g. mapping) nor quality (e.g. classification and components) nor quantity (e.g. database collection). The creation of a *riparian management area* would have initiated this process with the Forest Plan but the administration chose not to pursue this methodology. What has occurred on the KNF in its place has been a series of changing definitions of riparian areas and an inability to track them on even the most simplistic level. Today, no maps of current riparian ecosystem conditions exist for: (a) areas of one or two-sided riparian harvest; (b) areas of riparian habitat by width; (c) stream segments with bank cutting; (d) stream segments lacking large woody debris; (e) relative capability of natural tree recruitment; or (f) areas needing restoration. *Forest Service management never took a strategic approach to understanding and defining the condition of riparian areas and their components.* Nor has management attempted to map areas already degraded in order to prioritize restoration projects.

In theory, INFISH radically reverses the trend by establishing Riparian Habitat Conservation Areas around and along wetlands and streams. The RHCA is defined as:

"portions of watersheds where riparian-dependent resources receive primary emphasis, and management activities are subject to specific standards and guidelines. Riparian Habitat Conservation Areas include traditional riparian corridors, wetlands, intermittent streams, and other areas that help maintain the integrity of aquatic ecosystems by (1) influencing the delivery of coarse sediment, organic matter, and woody debris to streams, (2) providing root strength for channel stability, (3) shading the stream, and (4) protecting water quality." (USDA FS 1995:A-4)

RHCAs with fish-bearing *reaches* have 200-300 foot filter strips with limited salvage harvest and no firewood cutting within them (4 to 6 times as wide as Montana's HB731 requires and double or triple older pre-1994 KNF Riparian Guidelines). *Priority watersheds* include those with good fish habitat, adjacent areas for expanding fish populations, and restoration watersheds¹. Non-priority (i.e. non-fish bearing) RHCAs have 50 foot buffers. INFISH includes standards and guidelines for timber harvest and road construction, to limit grazing in restoration areas, and to adjust recreation, mining, fire and fuel management, and hydroelectric placement to fish recovery needs. INFISH also sets standards for general riparian management and watershed and fish habitat restoration. INFISH standards will protect riparian habitat while new management direction is developed through watershed and ecosystem analysis. Six steps are prescribed:

¹ *Restoration* implies management efforts and expenditures to improve instream habitat in order to re-establish absent or reverse declining fish populations. This can be accomplished through adding instream habitat components (LWD, pools, and shade), revegetating cleared areas, and correcting areas of channel instability (rip rap).

- 1) **Characterization of the Watershed**
 - a. Place the watershed in a broader geographic context
 - b. Highlight dominant features and processes with the watershed
- 2) **Identification of Issues and Key Questions**
 - a. Key questions and resource components
 - b. Determine which issues are appropriate to analyze at this scale
- 3) **Description of Current Condition**
- 4) **Description of Reference Conditions**
 - a. Establish ecologically and geomorphologically appropriate reference conditions for the watershed
- 5) **Interpretation of Information**
 - a. Provide comparison and interpretation of the current, historic, and reference conditions
- 6) **Recommendations**
 - a. Provide conclusions and recommendations to management

This INFISH directory of watershed analysis (USDA FS 1995:A-15) raises as many questions as it answers, continuing the ambiguity of Forest Plan monitoring. What scale of watershed is suitable for watershed analysis and how does the managing agency deal with processes with wide ranges from watershed to watershed? Forest managers prefer watershed scales small enough to reduce the need for time consuming and costly ecosystem analyses across basins and may find it convenient to use smaller management areas which allow associated problem areas to be left out of an analysis of a given drainage. The Upper Yaak FEIS included analysis of twenty-seven "watersheds" (7000 -

15,000 acres) on one scale but only half of the Yaak River drainage on another (the "Upper Yaak" - 284,000 acres). The issue of scale is discussed in scientific findings of the ICBEMP which used a scale of 56,000 acres for an average watershed and 19,000 acres for subwatersheds. Tradition on the KNF has been to do watershed analysis on the basis of compartments (about 10,000 acres) and sub-watersheds (1700 acres). Introduction of physiographic analysis in 1992 has created analysis areas similar to the ICBEMP subwatershed category.

On the KNF, microclimate conditions cause great natural variations between adjacent drainages which cannot be accurately predicted (MacDonald et al. 1997). The CSU study categorized water yield inputs by type (snow, rain, rain on spring snow, and rain on winter snow) and intensity, reaching the conclusion that natural variability allowed only a casual relationship to longitude, with eastern watersheds being drier and having fewer and less intensive peak flow events. From the start, analysis scale on the KNF is problematical when seeking reference data and similar hydrological events for comparison purposes.

INFISH continues a major KNF Forest Plan flaw in that it identifies issues and key questions before analyzing current conditions. This continues the major conflict between managerial agencies and environmentalists, the latter who feel that ground conditions should drive management direction, especially if restoration is needed. By identifying issues before identifying conditions, the timber target mentality will continue to regulate and drive policy decisions, leading to commitment of resources before ground conditions are known.

In seeking appropriate reference conditions, the problem faced on the KNF is that few remain of a suitable nature.

"Unfortunately we cannot separate out the risk due to management activities from the risk due to natural events because there are no data on the change in any of our response variables with the natural variations in discharge or sediment supply. Thus periodic measurements of key variables in relatively undisturbed basins are urgently needed to both assess the natural variability and evaluate the magnitude of response to natural events." (MacDonald et al. 1997:182)

"...we had relatively few reaches which were undisturbed or minimally-disturbed, and this made it difficult to determine reference conditions. We also cannot verify that our reference conditions were representative..." (MacDonald et al. 1997:177)

The roading, burning, sale, and harvest of areas in Red Top Creek during the first ten year planning cycle invalidated one of the KNF's oldest valid reference streams. A list of potential reference areas needs to be compiled, distinguished one from another by Rosgen classification, area, stream-flow regime, and level of previous activity.

In 1995, the KNF finally contracted to have thirty-four instream parameters monitored on eight reference drainages in order to assess the validity of the parameters in foretelling stream channel condition and to establish baseline data for KNF reference streams (Watershed Consulting 1995). This study should prove useful, when combined with Water Quality Bureau and USGS data from previous reference gathering studies, in

developing a long-term systematic strategy for the monitoring of reference streams and reaches.

As this report has indicated, interpretations of information and data (analyses) from which valid recommendations can be made have been few and far between during the first ten years of Forest Plan implementation. INFISH fails to resolve the problems of interpretation, peer review, and feedback that plagued the first Forest Plan. No reporting frequency nor level of interpretation is suggested for its variables. No demands for peer review of data analysis are made. Scientists, whether working for the government or working for private contracting organizations, often reflect the objectives and biases of their organizations (Schnaiberg 1977). The best formulation is to put results out for peer and public review, especially when they are translated into policy changes through feedback recommendations, thereby allowing whatever viewpoint on the findings to be openly expressed.

Research Design and Validation Monitoring

INFISH watershed analysis clearly lacks two discussions, the first of which will be dealt with here. Where does infield investigation design get developed and what models are to be used for it? The best INFISH can do is to describe Riparian Management Objectives (RMOs) with six variables to be measured, each with standards for interim objectives: pool frequency (minimum 1/55 feet, with increasing pool requirements with increasing width); water temperature (59° F summer, 48° F rearing period); large woody debris (> 20 pieces per mile, > 12 inches diameter, > 35 foot length); bank stability (> 80% stability);

lower bank angle (> 75% of banks with < 90° angle); and width/depth ratio (< 10 mean wetted width/mean depth). Each of these need to be "refined to better reflect conditions that are attainable in a specific watershed or stream reach on local geology, topography, climate, and potential vegetation." The RMOs provide the much needed managerial "out" - discretion - by saying,

"Interim RMOs provide the target toward which managers aim as they conduct resource management activities across the landscape. It is not expected that the objectives would be met instantaneously, but rather would be achieved over time. However, the intent of interim RMOs is not to establish a ceiling for what constitutes good habitat conditions." (USDA FS 1995:A-3)

INFISH, sadly, stops short of demanding systematic programmed monitoring and requisite changes in the Kootenai National Forest Forest Plan. The INFISH document's accompanying Table A-3 *"Interim standards and guidelines design considerations"* strangely is much weaker than those listed above that come from the main body of the INFISH document. Grazing, a known source of riparian degradation, has no guidelines and standards. Many required buffers in non-fish streams are actually narrower than those currently employed under the Kootenai Riparian Guidelines. As for the variables themselves, the CSU study clearly points to the fact that channel responses to harvesting are dissimilar between stream-flow types and that it is internal pool processes, like pool in-filling rates, not pools per miles, that indicate harvest effects and degradation possibilities. Bank stability, pool processes, large woody debris, and streamside management activity remain the factors of importance. Temperature, too, has been found

to be a limiting factor in some KNF streams such as Young and Dodge Creeks (Perkinson 1992).

As a step forward, INFISH establishes more exact riparian area definitions, much as did the KNF Riparian Guidelines of 1991. It allows timber harvest in riparian areas for salvage purposes, but otherwise strengthens protection for riparian vegetation. INFISH does not mandate any particular commitment of resources to evaluate stream and riparian conditions nor does it set any limits at which point feedback loops and management directional change must be mandated. In fact, INFISH can hardly be considered a strategic plan of action at all - it mandates a move towards common sense (at least what was common sense to the Cabinet Resource Group in 1987) but does not install or demand mechanisms to determine current stream quality or degradation limits, nor does it require management change in response to unacceptable conditions.

The Colorado State University study goes much further towards a discussion of metric variables than does INFISH, though it does not address riparian habitat conditions or ecology and is limited in scope to water yields and instream sedimentation parameters. At last there now exists an analysis of parameters for the KNF itself and a frank desire to see findings opened to peer review. The study concluded that "the complexity of any quantitative cumulative effects model precludes true validation" and that "the only channel response variables which could be directly linked to a change in discharge [on the KNF] was the observed increase in exposed bank in the pool-riffle and colluvial step-pool reaches." These conclusions argue strongly against relying solely on quantitative analysis

for both water yield and sediment accumulation effects on channel stability - both instrumental quantitative objectives in the unvalidated R1-WATSED model used on the KNF to guide management opportunities.

The difficulty in determining harvest levels from water yield and sediment movement comes from two sources - natural variability and the lack of reference streams mentioned above. Water yield was strongly affected by rain and snow interactions which varied year to year and drainage by drainage during the CSU study. While substantial evidence exists that extensive timber harvest increases peak spring flows (MacDonald et al. 1991; Bojonell 1993; MacDonald et al. 1997), the authors found little correlation between higher peak flows and several key monitoring indices on the KNF. "We found no evidence of significant change in channel dimensions [in response to higher peak flows], and only a weak significant relationship between the predicted water yield increase and Pfankuch's (1978) channel stability evaluation" (MacDonald et al. 1997:178). Instead, the CSU investigators found a significant relationship between the percent of exposed bank and predicted peak monthly water yield² in extensively cut basins, though some basins with minimal cuts show the same correlations. A second study suggested that timber harvest did not significantly increase water yields over natural conditions, but brought on peak flows earlier and extended them beyond normal expectancy (Luce 1997). Taken together, these two studies imply that duration of peak flows may be more closely related to timber

² Peak flows can be instantaneous flows or flows over longer periods. The latter seem to correlate closer to harvest activity effects on stream channel stability. KNF Peak Flow Increases represent three month averages - April, May, and June.

harvest effects and growing stream channel instability than the level of peak flow used by the KNF to guide harvest levels at this time.

Without enough reference reach data for comparison, it is difficult to judge harvest effects on streams due to the wide variability found in harvested drainages. Factors affecting variability within sediment calculations include gradient, particle-size, runoff efficiency, drainage area, and amount of large woody debris. "In terms of monitoring," reported the CSU study, "the focus [of quantitative studies] should be on bed-material particle size, particularly in pools" (MacDonald et al. 1997:177). Perhaps. But the author continues to maintain that it is not particle size but pool structural changes (in-filling rates) and LWD concentrations that show the real changes in sediment transport and storage. Even these must be adjusted to account for occasional sediment flushes from upstream storage (Bojonell 1993). The CSU study points to the need to develop an improved procedure to quantify bank erosion and add to the database for both reference and managed streams for fear that qualitative or ocular monitoring necessarily requires that degradation be reached before it can be detected. Until adequate sediment testing is complete in comparative drainages (10-20 square miles),

"managers can't identify the true cause of habitat degradation, and this severely limits their ability to develop effective BMPs, set management guidelines, and design efficient monitoring programs." (MacDonald et al. 1997:186)

This equivocation is perhaps a bit unwarranted, since evaluation that timber harvest and roadbuilding have degraded KNF streams can be found in fisheries reports (Perkinson 1989; 1992), in environmental assessments (KNF 1996b), in watershed analyses (KNF 1993; Wegner 1996), and in contracted stream stability studies (IWW 1993; Bojonell 1993). But the point is aptly made that riparian resource protection needs methods to predict problems before they grow into degradation sources in need of restoration.

The CSU study makes an interesting suggestion in their discussion of Pfankuch's Channel Stability Rating - the KNF's oldest and most used stream condition rating system. Recognizing that CSRs represent a rather arbitrary weighting of qualitative judgments, the authors recommend dispensing with the rating system and using either it or a similar survey procedure as a non-indexed (non-statistical) format to simply find and record problem areas and weaknesses. The great advantage of a qualitative system is that in-stream surveys of riparian habitat degradations could be mapped, tracked for cumulative effects with other problem areas, and set into the system of INFISH priority stream reaches and watersheds needing restoration work without costly and long-term commitments to systematic quantitative data collection. Furthermore, both the features page and the score sheet for the older Pfankuch surveys could be used and integrated into a historical record of former stream conditions. With this historical reconstruction, it might be possible to use database analysis to link periods and location of problem area formation with other habitat components and former timber harvest. But what of quantitative measures that might trigger required action and limit harvest levels?

Several important quantitative conclusions do derive from the CSU studies and those cited within it. First, it takes increased water yields from harvests of 15-20% of a drainage to significantly alter channels of formerly stable creek channels in the Northern Rockies. A quick study of the Timber Stand Inventory Database would allow the mapping of all drainages that have reached this level and when. These could be compared with Channel Stability Ratings that show high bank cutting and thereby possibly correlate to previous harvest. Secondly, when the predicted increase in peak monthly water yield exceeds 6-8% over an uncut drainage, there is a "qualitative shift in the response variables" - that is, location of exposed banks, extent of sediment deposits, sediment trap capacity, and infilling of pools with fine sediments. Finally, massive clearcutting of drainages often results in peak flow increases in western forests with maximum peak flow increase levels at 15% - actually below levels set in the Kootenai National Forest Forest Plan for many of its drainages. This suggests that a feedback index of 14% PFI, the most commonly used figure in WATSED calculations, may be set arbitrarily high and may, in cases, be closer to maximum instability than to safe thresholds. With 24% of the watersheds already exceeding this PFI limit (KNF 1997) and 41% at watershed condition limits based on five critical watershed factors (KNF 1993 - see Executive Summary, pg. 10), the CSU study clearly indicates that the KNF is managing its aquatic habitat beyond the peak flow increase levels the stream channels can handle.

Is the Kootenai Forest a degraded watershed? The scientific report of the ICBEMP classifies the area as one with high watershed integrity, though its evaluation somewhat misleadingly compares the partially forested lands of the KNF with heavily cleared

farmlands further down the drainage as a measure of "high integrity." Signs of chronic degradation do exist on the KNF. Degradation, while not proven by any of the metric monitoring by the KNF, is strongly indicated by the aforementioned reasons:

- 1) BMP risk factors are worse than Forest Plan standards, particularly when measured by the state;
- 2) the Forest Service failed to meet any of its monitoring criteria that should produce feedback and changes in practice or policy;
- 3) 41% of the watersheds are acknowledged to have reached or exceeded hydrological limits based on the KNF's own internal watershed assessment;
- 4) according to the CSU study, the Forest Plan models for peak flow increases limits set them arbitrarily high (14% or higher) when degradation often appears at 6-8% peak monthly flow increases, leaving little or no margin of error;
- 5) degradation evidence in streams and stream channels has appeared in greater numbers in the wetter 1990s, but it has not been recorded and tracked as monitoring has not emphasized the categorization of current stream conditions;
- 6) channel stability begins to fail at flow levels substantially below peak flow levels;
- 7) extensive two-sided and one-sided riparian clearcuts have a chronic effect on stream and riparian structure, particularly in the slow recovery and recruitment of large woody debris;
- 8) site specific monitoring continues to show persistent degradation from smaller projects, even when BMPs are adequately administered.

The time has arrived for a serious reevaluation of KNF monitoring practices and to call for turning the forest towards restoration work and the streams and riparian zones towards recovery. The next section addresses the issue of developing a database adequate

for future management and makes recommendations as to which parameters should be monitored and modeled.

APPENDIX 3: Part II

Reviewing the Methodology of Data Collection

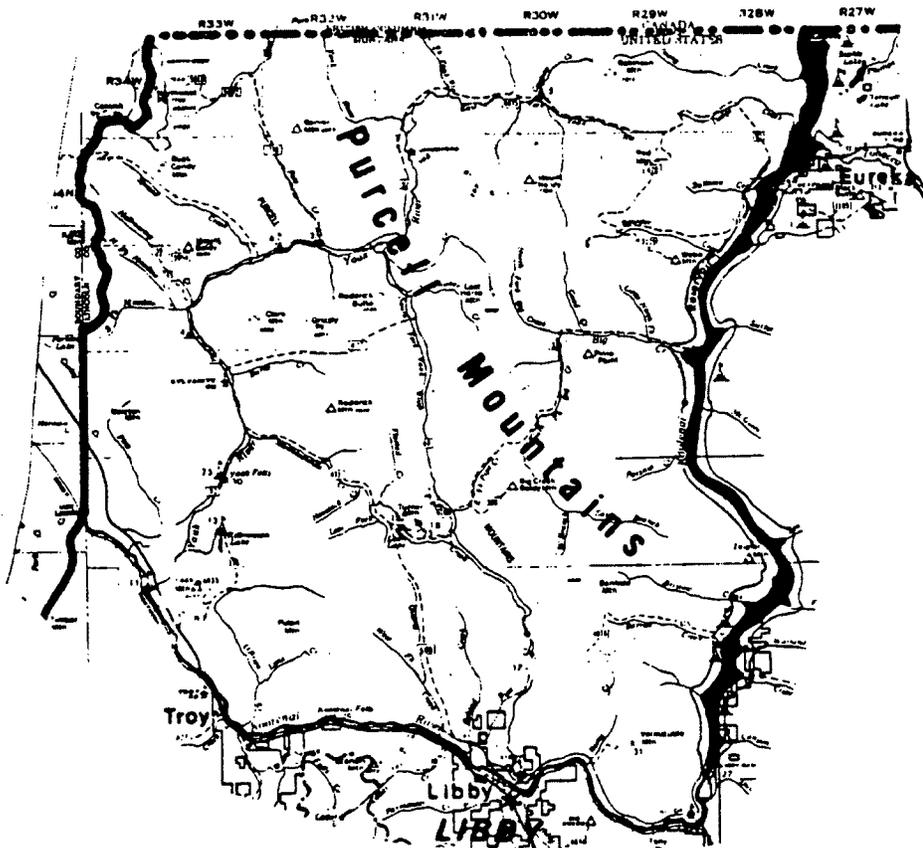
In the previous section, it was established that riparian management strategy trends are moving towards reduction, even elimination of timber harvest in riparian areas, towards watershed ecosystem analysis, and towards seeking more reliable and easier to collect data more indicative of actual, instream riparian health. On the other hand, agency reliance on models to predict and determine the effects caused by management activities continues to drive the need to design efficient, accurate, and standardized riparian health assessment methodologies, be they qualitative or quantitative. The need exists for a technical review of data collection and database storage techniques currently being used by the KNF. The following section is meant to assist hydrologists on the KNF in redesigning their monitoring programs in order to improve analytic utility and ultimately, riparian protection.

Untangling the Districts

To understand the difficulties encountered over the past ten years, it is necessary to understand the internal structure of the agency itself. The Kootenai National Forest began the Forest Plan cycle in 1987 with seven districts. These were consolidated into five districts in 1990 - Three Rivers (the old Troy and Sylvanite Districts), Canoe Gulch (the

old Libby and Canoe Gulch Districts), and the Rexford, Fortine and Cabinet Districts. The following analysis examines the practices and results of instream monitoring, data collection, database formation, GIS development, and summary reporting of the Three Rivers District, the Canoe Gulch District, and the Rexford District in what I call the Lower Purcell Range Analysis Area (LPR) in the northwest corner of the Kootenai National Forest. This area is bordered by the Kootenai River, which enters from Canada in the north and flows down through the towns of Libby and Troy and on west to Leonia at the Idaho border, Canada and Idaho (see Map 2).

Map 2 The NW Kootenai National Forest



The multi-district management jurisdiction of this area allows the opportunity to address the differences in monitoring practices between the districts as a backdrop to a discussion of the actual in-field monitoring results. This appendix includes a few references to documents produced in the Swamp-Edna Monitoring Program on the Fortine District and from the Supervisors Office (SO) in Libby, Montana, as well.

In spite of the Forest Plan being written and directed by the Supervisors Office, it is clearly the case in the Forest Service that the districts are relatively autonomous. Forest Rangers direct their districts as they see fit, and independent districts manage resources in the style that fits their budgets, management team concepts and timber cut priorities. The districts must design their projects under direction from and justified to Forest Plan guidelines and objectives. However, there are no *a priori* guarantees that each district will pursue similar techniques in monitoring design, sampling frequency, data collection techniques, database development or interpretive analysis. This was especially true in 1987 when the Forest Plan united the independent districts under a central guideline for the first time. Today, ten years later, it is my view that outside pressure, particularly from environmental organizations like the Cabinet Resource Group, have encouraged the districts to adopt more unity in their monitoring practices and a more scientific approach to monitoring than originally designed by the Forest Plan. This has been particularly true of riparian, aquatic, and water quality monitoring.

Except for the Swamp-Edna Monitoring Program, which resulted from a negotiated agreement between the Fortine District and CRG/AWA, monitoring programs have been designed, altered, and carried out without public input or review. In spite of submitted

comments on monitoring practices, no KNF Environmental Analysis has responded to public criticisms of the monitoring programs for site specific monitoring. In fact, the KNF maintains in its reply brief to last year's monitoring lawsuit that Forest Plan monitoring is not open to direct public challenge as "[monitoring's purpose is to make a threshold determination [whether] further inquiry is warranted," not to assess precise instream conditions (USDA FS 1997:2). The KNF goes on to maintain that the KNF's "duty to conduct studies is reviewable in the context of discrete, final decisions. ... [Finality, in turn, is determined by] "defined statements of policy, have direct and immediate effect on day to day business of complaining parties, having status of law, carrying the expectancy of immediate compliance" (KNF 1997:12). Otherwise, monitoring's purpose is to initiate reevaluations for Forest Plan amendments and revisions and to instigate changes in management direction should the Forest Supervisor choose to implement them. In 1992, changes in the monitoring plan were declared non-appealable (KNF 1993b). Perhaps environmentalists need to look closer at site specific monitoring decisions included in final project decisions such as Environmental Assessments and EISs.

This appendix analyzes data collection from information gathered through six Freedom of Information Act Requests. If monitoring cannot be challenged legally after Forest Plan adoption, then it is even more critical to criticize proposed hydrology monitoring practices and to demand that taxpayer dollars be used to build scientific databases rather than to justify timber sales during the revision process. I have deep respect for the hydrologists and fisheries biologists on the Kootenai National Forest but the nature of the Forest Service system - independent districts - has led to a chaotic and disorganized monitoring

methodology that jeopardizes the validity and usefulness of the data being collected. Until this situation is corrected, the Forest Plan Standards and Guidelines and their Monitoring Program will provide little assistance in the protection of beneficial uses and the data collected will remain useless for independent analysis.

Furthermore, successful monitoring hinges on a reliable funding mechanism to meet proposed monitoring costs. Most monitoring is conducted through K-V funds collected for site specific and project specific monitoring. But to say in a document that K-V Funds will be used for monitoring does not mean that they will be collected nor that, if collected, they will be spent on monitoring. In spite of promoting extensive and expensive monitoring programs during this Forest Plan cycle (Upper Yaak FEIS, the 316 Sales Monitoring Program, Arbo EIS, and 4th of July Fire Salvage EIS), the Three Rivers District reports spending only about \$6000/year on monitoring itself:

Chart A-3.1 1988-1996 Water Monitoring Expenses, Three Rivers District

Type of Riparian Monitoring	Total Expenses	9 Year Aver.
Monitoring Stabilization (BMPs and vegetative)	\$24,827	\$2,758.56
In-Channel Monitoring	\$13,939	\$1,548.77
Large Woody Debris Inventories	\$11,172	\$1,241.33
Fish Habitat Monitoring	\$5,074	\$563.78
Rip-rap Gabion Placement	\$12,510	—————
Total	\$67,522	\$6,112.44

Source: "1988 and On Project Expenses," Three Rivers District (TEC vs USDA FS 1997)

The low level of commitment by the Three Rivers administration to instream monitoring is evident in that only one-quarter of a year's salary for a Hydrology Technician has been spent for riparian monitoring during the previous Forest Plan cycle. An adequate

monitoring program must find better financial support if it is to reach its objectives of protecting beneficial uses and establishing a better database for future management decisions.

Critique of Current Monitoring Techniques

The lack of a common monitoring program design, inconsistent budgetary support and the constant evolution of monitoring practices in the last ten years has created a chaotic monitoring program. Chief design errors were: 1) the lack of a link between database collection and the input needs of decision models and computer tools; 2) confusion over the differences between riparian channel classification, component condition assessment and the monitoring of riparian processes; 3) a failure to build short-term project monitoring into a system of long-term database construction; and 4) a failure to follow through with proposed budgeting of project monitoring. The evolution of monitoring has produced reams of data that has little meaningful relationship to earlier baseline data as measured variables, methodology and sites have shifted. Research papers from the interim years provide direction for future investigations but yield few answers to key model validation questions. Ten more years have passed with little improvement in the understanding of hydrological limitations inherent in the KNF's riparian ecosystems. In the meantime, the KNF has been ordered to maintain its harvesting levels only slightly below historical levels (150 mmbf/yr vs. 184 mmbf/yr [Clark 1996]) with 41% of its watersheds already facing harvest limitations from watershed constraints (KNF 1993a).

The Role of GIS in Interpretation, Validation and Evaluation

Geographic Information Systems (GIS), which combine the mapping of spatial elements with database information concerning those elements, have revolutionized the tracking, monitoring, analysis, and relational interpretation of geophysical elements. The Kootenai National Forest began experimenting with GIS in 1994 and integrated its usage into its computer processes in 1996. Compared to when the Forest Plan was written in the mid-1980s, it is now easier to integrate a wide area of geographical information, timber stand data, timber harvest history data, and water quality and stream degradation information into a single analysis. GIS typically creates coverage layers, each with its own specific map elements and related informational database (like soil type, channel locations, etc.), and allows them to be overlaid by other layers in a way that joins their databases in new map coverages. Individual coverages can be enlarged and thus broken into their parts or made smaller and assembled into larger ecosystem analyses. As long as any piece of information has a spatial position, it can be relationally analyzed with any other piece of data. Four types of information are used in GIS work: spatial data, map projections and coordinate systems, aerial photographs, and remote sensing satellite images.

GIS Analysis Techniques Used in Riparian Analysis

Five GIS techniques described by Lyon and McCarthy (1995) include::

- 1) overlay analysis
- 2) buffering
- 3) network analysis
- 4) error analysis

5) modeling

Overlays are used to pick out map features that fall within the scope of others, such as locating areas of steep slopes and highly erodable soils. Buffers delimit areas along boundaries or linear features, such as 600 foot riparian corridors along priority fish streams in the INFISH analysis. Network analysis, using "dynamic segmentation", uses flow diagrams that are tied to data that sum as they travel down the diagram, such as water yield models of total water yield which increases steadily as one goes down a drainage. Error analysis is a form of risk analysis in that results are necessarily affected by mistakes made along the monitoring and analytical pathway. Results are never exactly correct, and a means must be developed to separate mechanical errors from natural variability, sampling error, and the like. Modeling refers to analysis that would, for example, select clearcut acres and roads (1 mile = 4 CCEs) from a watershed in order to define clearcut equivalent acres. WATSED uses CCE values as an input to determine peak flow increases for the drainages.

"Environmental models, linked with GIS capabilities, can allow managers to gather and display large amounts of spatially and temporally related data, to analyze those data within the framework of resource response strategies and economic constraints, and to make prioritization decisions based on those analyses." Ji and Mitchell (1995:32)

Three types of general modeling exist in GIS systems: (1) physical modeling of features and underlying environmental problems; (2) conceptual modeling of variables used to develop guidelines to direct managerial policies; and (3) analytic modeling for

validation and database manipulation, often limited by the programs software's capabilities. Selection of a particular model should be based upon its proposed function (how will it be used?), its proposed structure (suitability indices and feedback loops), and its variables (components and their characteristics). The original KNF Forest Plan Monitoring Program included poorly defined components, weak structure, and little strategic function. The practice of monitoring during the first ten years of the KNF Forest Plan is a story of changing components, ill-defined structure, and imprecise but increasing functional development of a research and instream monitoring program. Miles of fish bearing streams and Rosgen classifications have been mapped but other key riparian components such as woody debris, riparian width, pool locations have not. Goals and objectives of instream monitoring still are not clear, having produced a chaotic monitoring program, poor database development, and the inability to discern the protection of beneficial uses. Efforts have been put into validating WATSED but the CSU study indicates its weak relationship to stream channel quality. No sediment model has been proposed in its place.

Perhaps the best example of the incompatibility of data collection to computer analysis can be illustrated by a brief discussion of stream reaches. A reach is a contiguous segment of stream with similar geomorphological similarities. Both older Pfankuch Channel Stability Ratings (Pfankuch 1978) and more recent Rosgen streambed classifications (Rosgen 1996) use the idea of a *reach* as its basic unit to be measured. The change to Rosgen Classifications (after 1992) introduced a more or less stable, geomorphologically-rooted classification system in place of the arbitrary CSR reaches. Rosgen categories are based on visible shape and measured sinuosity (curvature),

gradient, entrenchment, width/depth ratios and particle-size distribution. But sadly, classification by Rosgen methodology varies among the three districts. Troy is the most exacting, categorizing a stream channel from its lowest point to its highest by intricately measured Rosgen reach characteristics. Libby, on the other hand, has chosen to measure only the reaches for its monitoring station sites, leaving intermediate reaches between sites of unknown classification. Rexford uses rough visual field estimates for the bulk of its gradient, sinuosity, and entrenchment ratios - casting doubt on their future utility for further statistical calculations which are "the foundation for predicting instream changes that may occur due to land management activities." (KNF 1997:7).

The Swamp-Edna Monitoring Report discusses four level of Rosgen analysis:

Four Levels of Rosgen Stream Channel Analysis

Level 1: describe watershed geomorphology and landforms;

Level 2: measure reach variables and type stream geomorphology;

Level 3: describe existing state in terms of stability, response potential, and function; monitor stability through dimension, pattern and profile through variables of riparian vegetation, deposition pattern, debris occurrence, meander pattern, sediment supply, and flow regime; comparisons with reference streams;

Level 4: sediment, streamflow, and stability measurements for validation of predictions arising from other three levels; establish stream cross-sections with permanent monuments for assessment.

Although this CRG-negotiated monitoring plan is the most strategically comprehensive plan on the KNF, still no clear relationships between qualitative classification variables and

numerical measurements are described, leaving analysis of variables, collection of data, and reporting of results to management discretion. In four years of Rosgen classifications, not one summary Rosgen report has been produced, no long-term trend reference streams delineated, and no models have been developed that measure sediment, streamflow, and stability in a way that validate the classifications, to say nothing of validating the effects of timber harvest on Rosgen classified reaches. The CSU study casts doubt on Rosgen validity on the KNF, pointing out that Rosgen's expected entrenchment ratios and width/depth ratios do not statistically fit channel types on the forest.

On the other hand, the KNF uses three other stream reach systems - the Channel Stability Ratings, the KNF Riparian Classifications, and the INFISH stream classifications. All are qualitative reach determinations. CSRs are designed to pinpoint visual problems of hydrological instability in the reaches, scoring problem areas according to a tally sheet. Unfortunately, they have little inter-drainage comparability (KNF 1996) due to the training levels and experience of investigators. Furthermore, by totaling the score, identification of individual problems are lost (MacDonald et al. 1997). They do have the advantage of including on-site inspections of current conditions and have a record of historical use on the KNF - providing a picture of stream condition and health over the years. No attempt has been made to calibrate KNF Channel Stability Ratings to Rosgen reach classifications, a need identified by David Rosgen and local hydrologists alike (Rosgen 1996; Sullivan 1996 pers. com.). KNF Riparian Classification are generalized streamflow types and useful only in determining levels of riparian protection required under the Forest Plan Guidelines. INFISH standards are practically worthless except they identify fish habitat

and possible restoration priorities, whatever restoration may mean. None of the four systems of classification use identical reaches, meaning that computers must track four different reach categories simultaneously. The CSU study has proposed a fifth reach classification scheme in order to better correlate data with timber harvest effects.

Worse yet, none of these systems fits computer program identification methods of stream segments. What is real and obvious to the human eye is quite different from a computer's perspective. This forces the use of *dynamic segmentation* - a GIS method which identifies characteristics as events along predetermined (and arbitrary) stream routes. *The use of dynamic segmentation, which ties data to routes, means that independent analysts will have to use the same routes as those chosen by the Forest Service.* Anyone wishing to analyze Forest Service data in the future will have to do it by using Forest Service basemaps of routes. This puts additional emphasis on accuracy (error reduction) on the part of the Forest Service and on data transferal ease to those operating outside of the agency.

Assuming that Rosgen classifications can be calibrated to KNF streams, each stream would need to be categorized by the qualitative and quantifiable variables at the Rosgen Level 3. Then it becomes necessary to quantitatively measure for stream processes as a means to validate classification schemes. However, the districts show no rational plan for data collection and database storage. Four reasons exist for this. First, the entire KNF is operating without a strategic plan and monitoring is being driven by timber sale projects rather than scientific investigation. Sampling procedure and timing is a function of other considerations, not of establishing baseline or reference stream data. Second, no

standardized data collection forms exist. Thus one district uses one form with certain variables and another uses other forms with other variables. There is no consistency to forest-wide monitoring. I found seventeen forms in use and twenty six methods of recording data in information reviewed under the FOIA requests on the three districts. Very few correlated to others in a way that allowed them to be interchangeably entered into a database and several had been significantly changed during the last five years, making the first five years of investigation incapable of being correlated with later years. Third, GIS and computer models remain undeveloped, making it difficult to know what variables should be measured to fit needed computer inputs. Finally, inconsistent sampling periods make statistical analysis of KNF data either impossible to analyze and compare or unreliable.

Given the responsibility of trying to validate the WATSED model, the Canoe Gulch District established a series of constant recording flow stations and channel cross-sections that may prove useful to model validation. The Three Rivers District established many flow/cross-section gauge stations but monitors them once a year depending on personnel and other projects, providing such little information on flow and water yield as to be meaningless. However, they have an extensive cross section monitoring program that may prove useful in long-term monitoring analysis. Rexford, on the other hand, has little experience with instream monitoring, just initiating flow stations in 1996. The Fortine District monitors the five Swamp-Edna stations under a negotiated agreement with CRG and soon plans an extensive project summary analysis, the first under the Forest Plan. However, the fact that the hydrologists failed to record that one station was abandoned in

the middle of its seven year monitoring cycle because rapid sedimentation caused by intensive forest management upstream and cattle damage to banks lifted its crest gauge out of the water, indicates a severe lack of attention to critical detail that is necessary for accurate long-range statistical data collection.

Database entry is another worrisome effort. Rexford began entering its data into computers in 1992, establishing reaches using fine cross-hairs on maps of stream locations in latitude and longitude. Hopefully, this data will be transferable to GIS, but the fact that exact locations on the USGS Cartographic Feature Files (CFF files) were not used for reference points may yet prove a GIS mapper's nightmare. Rexford also entered its data in the IBM spreadsheet software package known as Excel in a manner that showed no clear understanding of database retrieval. All data should be entered into a 'dbf' database or similar convertible file structure which is directly used by GIS programs. If it takes special training of hydrologists to use appropriate file structure then so be it - the data must be directly accessible to GIS technology. Three Rivers has entered a portion of its data in the old Data General format, not readily transferable to new software programs. Little data has of yet been entered, but recent adoption of a mathematical identification system for the naming of stream routes will bring about rapid changes in analytic capabilities in coming years (see Appendix 4). Canoe Gulch has yet to begin data entry. No effort has been made to establish reference streams and reference databases to date by any district or the Supervisors Office. The fact is that GIS and database operations are new to the Forest Service (1995). It may take years to establish a working system from which the data can be used in relational layers for the purpose of analyzing sediment movement, streamflow

regimes, and stability measurements, assuming, of course, that the correct parameters are being measured.

That is not a high probability. Einstein (1950) used 97 variables and constants to formulate his famous calculations of bedload movement and sediment transport! To expect clear results of hydrological process monitoring to come from the Forest Service monitoring program requires a leap of faith given limited funding resources and limited hydrological technical experience among its hydrologists.

Even when efforts are made to quantify monitoring, the Forest Service often presents strangely conflicting positions to the public on that monitoring. In 1994, the Swamp-Edna monitoring abandoned *embeddedness* after a few years of monitoring as an unreliable variable while the 1996 Annual Report (1997:60) states that

"The monitoring data suggests a relationship between stream surface sediment, and the annual total water yield and high flow conditions for the watershed. ... The use of embeddedness monitoring as a data source should continue."

The signals on what constitutes reliability remain mixed for many monitoring variables - embeddedness, flow discharge, pebble size distribution, and sedimentation levels among others.

The continuation of particle size distribution using the Wolman Pebble Count (introduced in 1994 after collecting samples by two other methods previously) is being promoted throughout the forest in conjunction with RSI measurements and channel cross-sections in order to establish bedload movement and, indirectly, embeddedness.

However, nowhere is it made clear how particle size is related to stream channel stability. The CSU study points out that particle size has statistical correlations to annual monthly water yields when pool substrate is measured, not just anywhere a monitoring station or reach is established. Monitoring stations and reaches are not designated to study pool formation, infilling, and characteristics. In fact, older pool/riffle ratios have been dropped from the Three Rivers and Rexford Districts. Canoe Gulch, on the other hand, improved and instituted fish survey forms that accurately measure pool size and depth, though locational benchmarks are not used for cross-year comparisons.

As stated earlier, environmental data collected in an unsystematic manner rarely provides useful information for trend analysis, possibly explaining why virtually no summaries of KNF water quality monitoring results have been produced. The Canoe Gulch hydrologists have taken the responsibility of trying to validate the WATSED model for peak flow increases and sedimentation movement. To date, from preliminary analysis of a couple of streams, it appears that model predictions of peak flow increases are weakly correlated with measured flow levels but that sedimentation predictions are not correlated to any sedimentation measures (Wegner 1996, pers. com.). The testing is not following a strategic validation monitoring plan nor have progress reports been circulated to peer review. Strangely, no summary or progress reports exist on any other data either, and it appears that monitoring programs initiated under timber sale projects are merely dropped without interpretation upon the sale's completion. The public awaits major monitoring reports from countless smaller projects. It seems doubtful that a new monitoring plan and

new guidelines and objectives should be developed in a revised Forest Plan before an effort is made to analyze, interpret, and evaluate previous monitoring projects.

Defining model development needs and key variables are to be the subject of Appendix 5. However, first it is good to offer the following case study by the author to pinpoint GIS and database problems and potentials that will be needed during the planning of a monitoring program for the second ten years of the Kootenai Forest Plan.

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Appendix 4

The Lower Purcell Range GIS Project

In 1993, following release of the 1992 KNF Annual Monitoring Report which found monitoring results "inconclusive" for most riparian parameters, the author initiated a Geographic Information System (GIS) mapping project to illustrate riparian mapping/analysis techniques and to locate recognized instream problem sites. At the time, the Forest Service used an archaic General Data computer system that made spatial GIS analysis difficult and cumbersome. Only one District, Rexford, was even using computer technology to track water quality data. What might have been a landmark analysis by the author was later slowed from two directions: the database format used by the Forest Service proved incompatible with GIS software, and the author spent a year and a half in Central America on a Fulbright Scholarship. The first required that the author invent a naming and numbering convention to link data in the database to stream segments for mapping which then required extensive time-consuming data entry to link the data to map components. The second delayed the project for nearly two years.

In 1995, the Forest Service initiated its use of IBM compatible computer networking, including the use of ARC/INFO GIS and ARCVIEW. For the first time, the Forest Service began using software compatible to software being used by environmental organizations elsewhere. The change initiated the on-going reorganization of the database structure used by the Forest Service to record its water quality data. This promises great improvement in tracking and analyzing data in the future and for the open transfer of information between the Forest Service and outside oversight organizations. While the

first ten years of monitoring produced sporadic and somewhat confused data searches on the KNF, the next ten promise more technical capabilities for tracking and analysis of instream processes and conditions. The following GIS case study of the Lower Purcell Range analysis area, roughly the upper northwest third of the Kootenai National Forest, is presented here to illustrate some of the possibilities and problems related to GIS analysis.

Four data layers are involved in the following analysis: (1) KNF watersheds; (2) the USGS Cartographic Feature File (CFF) for streams; (3) district boundaries; and (4) timber stand maps. The watersheds, districts, and timber stands are polygon features while the stream CFF is composed of line features. *It is the correlation between linear data and area data that is so difficult and so important to KNF interpretation and monitoring.*

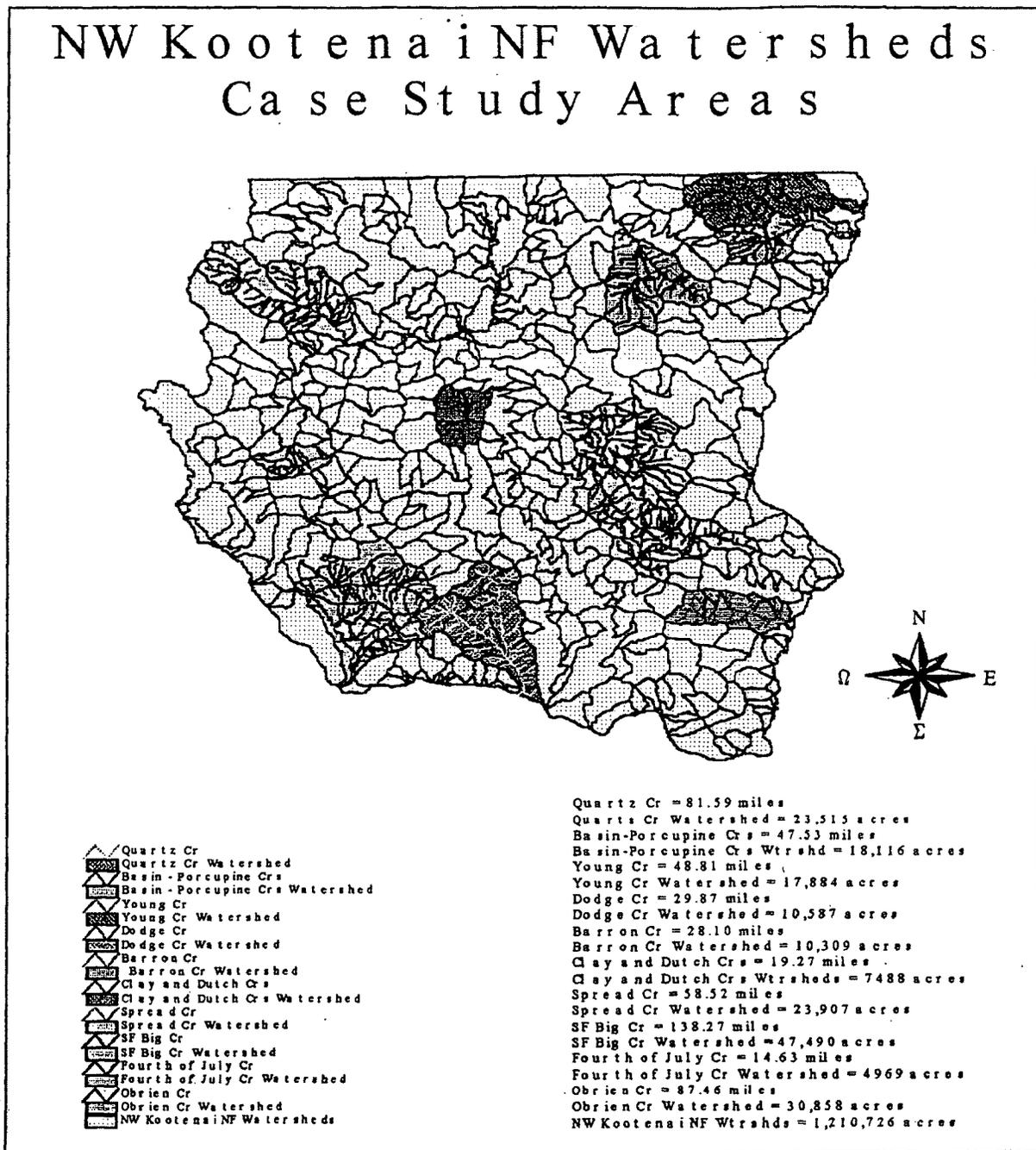
These maps are only primitive forms of what the author can imagine possible, limited by skills and available time on a computer with mapping software.¹ Still, they show clearly the types of analysis that must be standardized within the monitoring procedures if the public is to expect better performance of riparian monitoring in the second ten year cycle.

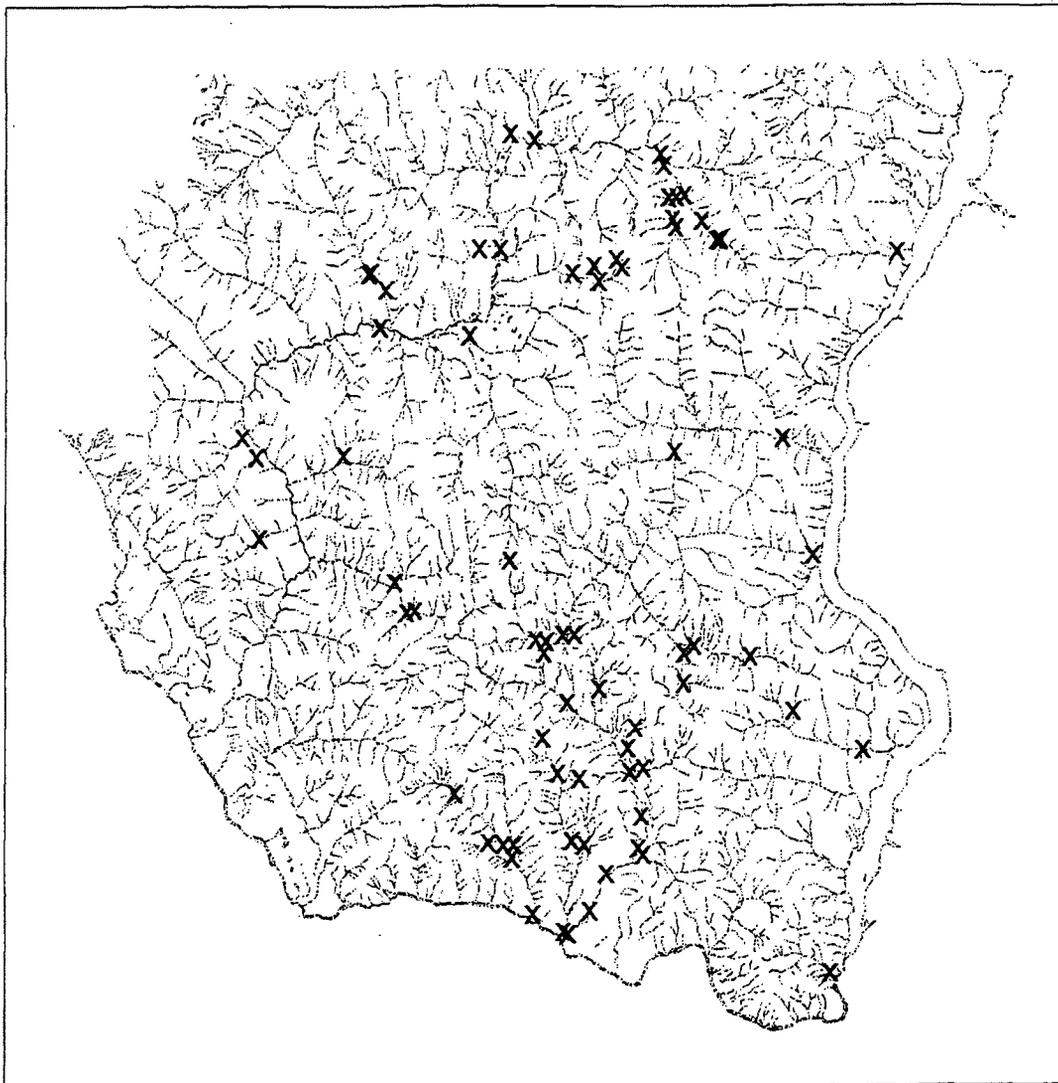
The Lower Purcell Range Analysis Area (LPR) is illustrated in Map A-4.1 and its monitoring stations are shown in Map A-4.2. The LPR is a 304.83 square mile area bordered by Idaho to the west, Canada to the north, and the Kootenai River and Koocanusa Reservoir to the south and east. It has 725 designated subwatersheds, 2519.9 miles of stream channel (on USGS cartographic feature maps), and

¹ The monitoring study was funded by the Patagonia Foundation and the Norcross Wildlife Foundation.

Computer assistance was provided by the Forest Service, Conservation Imaging of Moscow, Idaho, and by the Ecology Center in Missoula, Montana.

Map A-4.1 The Lower Purcell Range Analysis Area



Map A-4.2 Monitoring Stations in the Lower Purcell Range

a six order structure that includes 5037 stream channel segments.² This Montana stretch of the Kootenai River basin has 225 tributaries that range from first order creeks to the

sixth order Yaak River, one hundred ten of which enter the Kootenai River from the LPR analysis area. This case study focuses in on the ten colored watersheds on the map, selected for representative qualities including size, fisheries, fire and management regime. In two cases, the Basin/Porcupine and Clay/Dutch drainages, drainage areas separated by traditional naming convention are grouped to represent single instream cumulative outflows at monitoring stations.

Besides these management categories, the KNF tracks many other spatial overlays in the area related to other management goals: analysis areas, management areas, bear management units, compartments, sub-compartments, timber stands, soil types, quad maps, and vegetation maps. The analysis area of 1,210,726 acres is about 40% of the KNF - clearly only a portion of the complex management system on the forest. The case study drainages represent 16.12% of the analysis area.

channel between two intersections. Order is a definition of stream complexity with first order streams being headwater channels which join to form second order creeks. Two second order streams join to form a third order etc. The Kootenai system taken as a whole is a six order stream network. Most analysis in the past was done on a compartment basis, a compartment being roughly a watershed of 10,000-15,000 acres, usually representing a third or fourth order drainage.

Table A-4.1 Case Study Drainage Statistics - Miles of Stream and Drainage Acres

Drainage	Length in miles	# of Seg.	Rank for miles	miles/ seg.	Rank mi/ seg.	# sub- wtrshd	acres	Rank in acres	acres /mile	Rank acre/mi.
4th of July	14.633 8	25	10	0.585	5	3	4969	10	339.56	9
Clay - Dutch	19.272 9	68	9	0.283	10	3	7488	9	388.52	2
Barron	28.099 2	41	8	0.685	2	7	10309	8	366.88	4
Dodge	29.868	49	7	0.61	3	5	10587	7	354.46	6
Spread	58.518 1	83	6	0.705	1	13	23907	3	408.54	1
Basin - Porcupi.	47.528 3	80	5	0.594	4	8	18116	5	381.16	3
Young	48.813 7	107	4	0.456	9	13	17884	6	366.37	5
Quartz	81.591 9	142	3	0.574	6	11	23515	4	288.2	10
Obrien	87.462 3	164	2	0.533	8	14	30858	2	352.81	7
SF Big	138.26 7	244	1	0.567	7	23	47490	1	343.46	8
NW KNF	2519.8	503 7		0.5002		725	1210726		480.47	

The tabular summation above, produced with GIS analysis, shows some interesting facts concerning the structural variation found within KNF drainages. The case study basins are ranked on the basis of four variables: length of total stream miles, average length per segment (i.e. between creek junctions), number of acres, and acres per mile of stream. Rank in miles correlates well with rank in acres but segment length and drainage

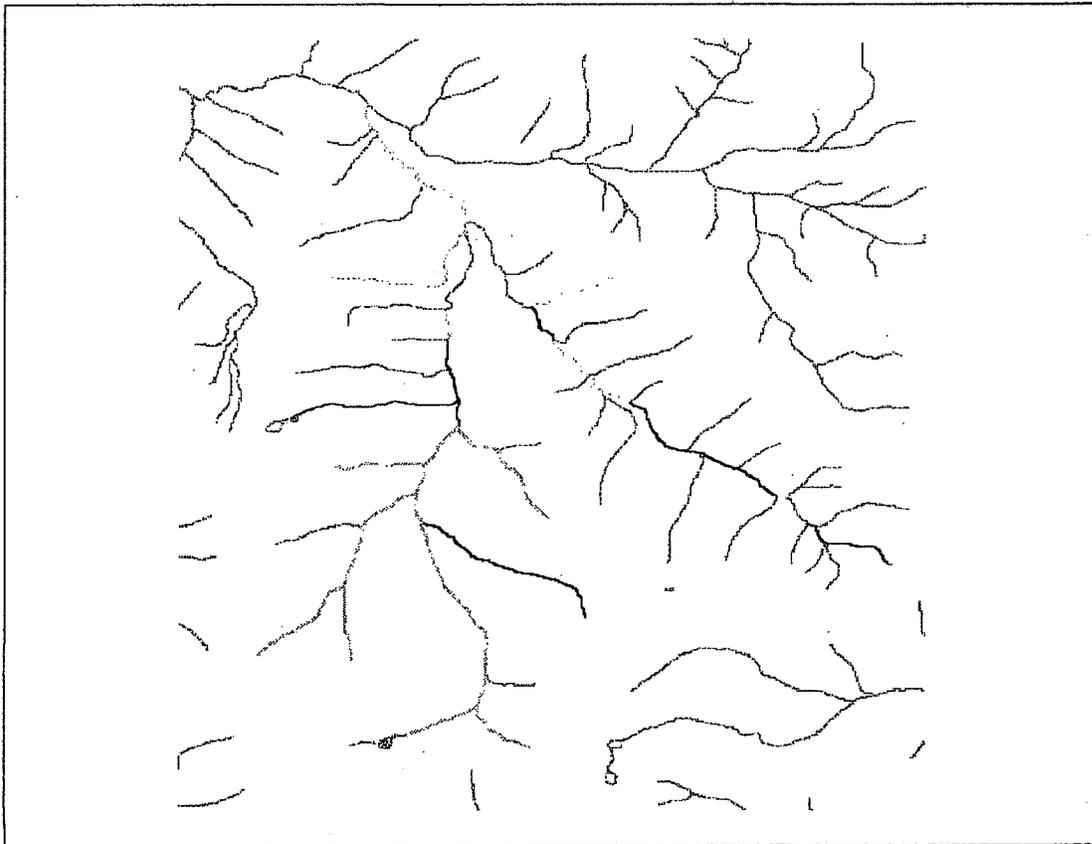
area per mile do not follow logical patterns. Clay/Dutch is particularly convoluted, with the shortest stream segments and nearly the largest area per segment mile. Spread Creek, on the other hand, has the longest stream segments and the largest area per mile. Fourth of July Creek has fairly long segments but small drainage areas. When looking for reference reaches and streams, it is obvious from the start that unless samples are substantially large in number, the natural variation will make results "inconclusive" in terms of statistical analysis.

The object of GIS mapping analysis is to relate characteristics of forest components, maintained in database format, with their physical locations as a means for comparison through time or with other reference features. GIS permits the ready mapping of different characteristics of a given feature (e.g. a Rosgen stream type or a Channel Stability Rating for a specific stream reach) or an analysis of its relationship to other features (i.e. linking stream channel to timber stands that border creekbeds and hence contain riparian areas). Map A-4.3 illustrates the first by mapping segments with measured stream channel stability ratings in Basin and Porcupine Creeks while Map A-4.4 illustrates the stands with known riparian habitat in the same drainages. By linking the two and then querying the stand database, it is possible, for example, to analyze historical harvest activity above a given segment of concern to establish possible management activity-channel instability relationships.

Before turning to the issue of data tracking and statistical analysis, it is useful to discuss some of the practical problems encountered in attempting this GIS analysis of KNF data.

The stream/watershed dichotomy presents an intriguing and beguiling duality: the first is a linear feature while the second is an area one (actually a three dimensional form). Thus,

Map A-4.3 Channel Stability Ratings - Basin and Porcupine Creeks

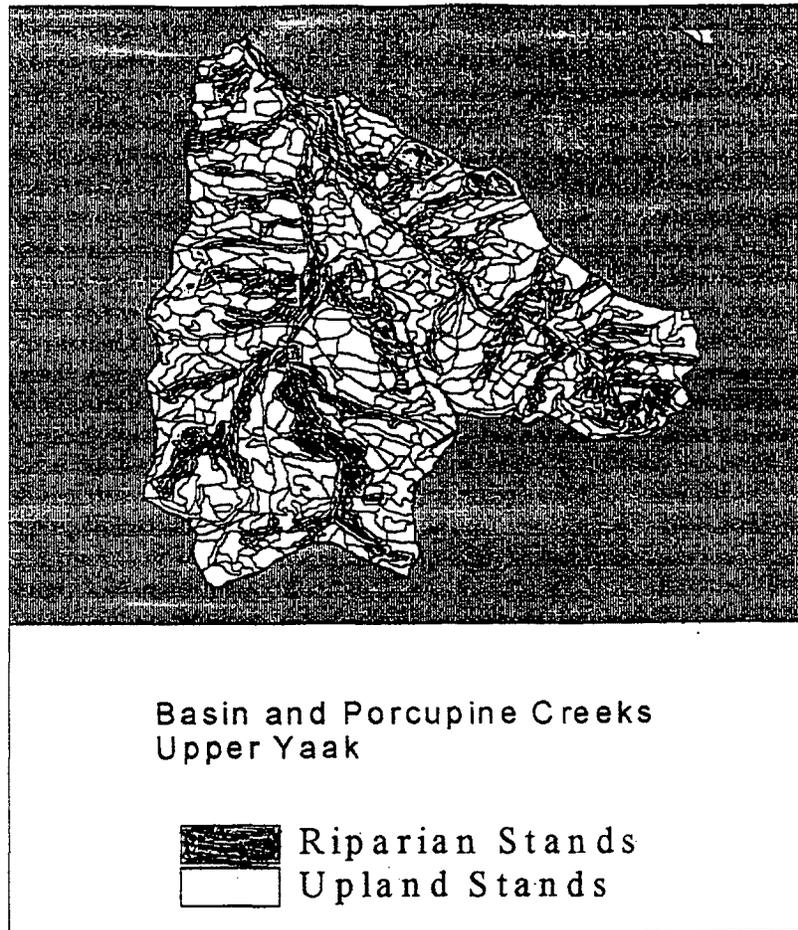


**Basin and Porcupine Creek
Pfanckuch Channel Stability Ratings**

Channel Stability Ratings

-  0 - Not Measured
-  1 - 38 Excellent
-  39 - 76 Good
-  76 - 90 Occasional Monitoring Needed
-  90 - 100 Area of Concern - Annual Monitoring
-  100 - 115 Problem Areas - Restoration Needed
-  Streams

Map A-4.4 Basin and Porcupine Creeks - Riparian Stands



from the beginning, water quality analysis involves both linear and multi-dimensional spatial analysis. Linking one to the other is instrumental in linking timber management effects on stream channel stability and instream aquatic habitat health, certainly easier said than done.

Linear stream data on the KNF is recorded in reaches which, in the past, had no relationship to stream segments (between intersections), stream order (complexity), names or numbers. In fact, some reaches are labeled in the KNF database going upstream, others downstream, often one reach is not contiguous with another. Because computers require

a rational labeling system that ties data to specific locations, the Forest Service and other agencies have had to invent a linear labeling system - known in ARC/INFO as *routes* - which tie collected data to specific portions of stream channels. This labeling system, currently being adopted throughout the west by state and federal agencies, is drawn from USGS cartographic feature files developed earlier in the century. Routes consists of a start point, a single linear stream ignoring its branches, and a length. Selecting arbitrary start points, the Forest Service assigned rough latitude/longitude designations to the start point and then developed the longest identifiable routes upstream from that point. The route is thus identified by its startpoint using the first four digits of its latitude and first four digits of its longitude and then adding a three number code for its total length (in kilometers), creating an eleven digit route identification code. Upstream branches that are shorter in length are numbered as separate routes using the same process until each stream segment on the USGS CF file has a route label. As reaches and features are identified along any given stream route, they are given the route identification number with additional reach specific start and end distances, allowing the computer to track data as an "event" in time along a particular stretch of the stream route in question. In the route system, the original arbitrary route labels are never changed. Instead, events are added to *relational databases* tied to the route through its identification number and the distance upstream to the location of the particular event. The system has this advantage of stability in that if new streams are discovered, they can be added to the cartographic feature file without altering that which has already been created.

As designed by the Forest Service and other agencies, the route system has a considerable number of disadvantages that need to be considered by the public and oversight organizations. First, the route labeling system has no common names attached and as such the database provides no clues as to location to people unaccustomed to dealing with computers and technical mapping. This immediately elevates the need for computer technicians in order to assess data of any sort. Because the labeling follows no obvious naming convention, the expensive software ARC/INFO becomes a necessity for data analysis and comparison and computer technology centers become increasingly important in oversight activities. Second, the designation of arbitrary routes based on distance rather than stream order (i.e. complexity) places reaches different in both flow and channel characteristics into the same route. **Any attempt to summarize or average data over a route will be statistical and analytical tomfoolery!** Reach variation and flow mechanisms do not permit generalization over long distances (Bojonell 1993; MacDonald et al. 1997), particularly when there is no rational (i.e. statistical) basis for their selection in the first place. In addition, the most significant flow routes in a drainage may *not* be the longest ones but the ones which drain the largest areas or the steepest areas. Forest Service routes do not reflect critical physical characteristics and conditions and these must be accurately and unbiasedly accounted for during the analytical processes. Monitoring the monitors will become more difficult and require greater concern and expertise on the part of oversight organizations in the future. Third, the USGS Cartographic Feature Files are based on pre-technology assumptions that are not necessarily accurate in the field. Table A-4/2 illustrates the differences between the CFF

stream representations and those found with diligent survey techniques on the Three Rivers District.

Table A-4.2 Differences between Field Surveys and USGS Cartographic Feature Files

Drainage	Length in Miles - CFF	# of Segments - CFF	Length in Miles - actual	% Change in Length	# of Reach Segments ¹
Clay/Dutch Cr.	19.2729	68	25.827	34.01%	128
Spread Cr.	58.5181	83	67.461	15.28%	178
Basin/Porcupine Crs.	47.5283	80	50.0358	5.27%	135
Obrien Cr.	87.4623	164	107.2214	22.59%	291

¹ Due to my methodology, I was unable to calculate the actual number of segments. This figure represents the actual number of segments and their divisions based on reach classifications from Rosgen and CSR surveys.

These examples illustrate the importance of accurate instream assessments prior to statistical analysis for any variable as area/stream mile will fluctuate based on infield inventories. Fourth, the effects from management activities will flow downstream, often intersecting and overlapping parts of other routes. Since routes were not chosen to accumulate going downstream, analysis will necessarily require the subdivision of routes for cumulative analysis of sedimentation and flow effects. That can be accomplished only through the overlaying of Digital Elevation Models (DEM) and the selection of areas using flow criteria. The resulting effects to oversight organizations from these considerations are: (1) all organizations will have to use Forest Service route labels to

track water quality and riparian habitat data; (2) organizations will need to have DEMs along with route information in order to analyze spatial and cumulative impacts; and (3) the public will be dependent on accurate, timely, and convenient updates in order to track data because data will be tied to routes rather than to particular map elements such as stream segments.

Working with area data has produced many other difficulties that make analysis difficult and systematic updates essential. When working with watershed analysis, basing layers on DEMs makes sense as water flows downhill. Presumably, the watershed and subwatershed designations on the KNF follow DEM modeling, though it should be understood that many of the subwatersheds themselves encompass more than one sub-subwatershed and thus are not unique in their own right. However, watershed characteristics often do not match other forest components that are crucial to analyzing timber management effects on aquatic habitat. The KNF uses a variety of spatial schemes: district boundaries as managerial responsibility dividers; physiographic boundaries or area analyses; compartment and subcompartment boundaries as sub-managerial divisions which reflect watershed concerns; stand boundaries which reflect the natural variation in timber composition; and elevation, slope and soil distribution. These non-watershed maps often predate computer analysis which, by the nature of the beast, either sets boundary lines in stone or necessitates endless updates. *Overlaying the various KNF layers on top of each other produces a nightmare of what GIS workers call 'slivers' - small, unusable polygons that demand correction or they invite computer and database malfunctions.* The KNF needs to correct these overlay discrepancies along whatever course of arbitrary

decision-making it so chooses so that a once and final baseline database of spatial and managerial characteristics is developed. A computer can track as minute detail as is required for accurate analysis, but it is ridiculous to carry forward meaningless polygons in the name of tradition: if ridge stands are cut by watershed, compartment, and/or district lines, then cut them into two stands and use the same dividing line for stands, compartments, watersheds, and districts. Then distribute the updated maps to oversight organizations who have already requested the map information so that everyone starts with the same baseline map features. Waiting only confuses the work of oversight groups and makes the job of using future data more difficult for everyone, the Forest Service included.

Two other problems cropped up in trying to select areas using linear stream features. Many stands have more than one stream and often the streams are of different order and have different streamflow characterization. This indicates that good watershed analysis may require that only portions of certain stands be queried because in actuality they consist of area within more than one sub-subdrainage. The KNF has chosen to operate on subdrainage areas of approximately 1700 acres but these do not fit their stand data and include more than one creek. Slowly correcting stand boundaries to subwatershed boundary lines will facilitate future analysis and should be done on a project by project basis. Secondly, there is no way to query riparian areas as these are not tracked by the KNF. In fact, a 1991 study done to help determine KNF Streamside Management Zone (SMZ) widths for the Forest Plan (Pfister et al. 1991) , found SMZs to be generally 60-650 feet wide, with some reaching as wide as 1300 feet. Yet the KNF selected only

100 feet per side for its Forest Plan SMZ width and HB731 set only 50 feet for SMZ width. Developing accurate maps of true riparian habitat widths will be an important factor in assessing watershed riparian health.

The Next Step

Once linear and area features are mapped and technological problems overcome, the real task of analysis lies ahead. What can mapping analysis show us about the effects of timber harvest on riparian health? By selecting specific problem areas, it will be possible to reconstruct the harvest history above these points in order to test hypotheses about what level of harvest induces channel instability. Also, by using buffers and historical stand data, accurate assessment of the natural conditions of riparian areas, their size, and their components can be developed from which restoration plans can be adequately developed. These, and many similar types of analyses are just now becoming technologically feasible and they should be available for analysis that will predate the reformulation of a KNF Monitoring Plan during the Forest Plan Revisions.

References for Appendix 4

- Bojonell, Hilaire Ann. 1993. "Assessing Factors Contributing to Sediment Storage in Headwater Streams in Northwest Montana." Masters Thesis, Northern Arizona University.
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- Pfister, Robert; Boggs, Keith; McCullough, Mike; and Rebecca Baldwin. 1991. "Methodology for Riparian Inventory and Streamside Management Zone Delineation on the Kootenai National Forest." Montana Riparian Association, University of Montana, Missoula..

Appendix 5 Outline for the KNF Forest Plan Riparian Monitoring Plan Revisions

This Appendix presents the author's ideas and recommendations for revisions in the Forest Plan Riparian Monitoring Plan. These ideas are presented in outline form in an effort to maximize ease and speed of reading them, and so that this Appendix may be reproduced easily and inexpensively without losing key points. Most of the following points have already been raised in other sections of this paper, but this Appendix organizes them into a straightforward outline aimed at confronting major issues in the Forest Plan Revision process. The outline has three sections. Section One examines management objectives, strategies, and standards. It lays out the steps that the Forest Service will have to accomplish before a new, revised monitoring plan should be accepted by the public and suggests a timeline for Forest Plan Revisions. The second section examines issues underlying monitoring objectives and asks questions that need to be answered before a new monitoring plan can be developed and accepted. The final section proposes corrective measures for past monitoring problems and offers suggestions as to which parameters and methods appear most suitable for monitoring during the next Forest Plan cycle.

I. How to Convert the KNF Forest Plan Monitoring Plan into a Macro-watershed Analysis Tool

A. How should the Forest Plan be revised?

- 1. Re-examine Riparian Management Objectives and Goals on the Forest Plan level**
 - a. How did the original goals clarify differences in trend and event monitoring?
 - b. What were the summary results of the first ten years of monitoring?
 - c. Did the original plan meet its objectives and protect beneficial uses?
- 2. Re-examine the reasons behind Forest difficulties in completing the following essential tasks:**
 - a. Summarize historical and current conditions forest-wide
 - b. Develop and validate management models including water and sediment yield models, riparian habitat condition models, and watershed condition assessment models
 - c. Select consistent monitoring variables and design effective database structure capable of model and trend analysis
 - d. Standardize data collection across the Forest
 - e. Plan project monitoring to assist trend analysis

- f. Develop criteria for prioritizing watershed and management activity through instream condition and needs assessments
- g. Guarantee systematic and timely reporting of project monitoring
- h. Prepare and make available two, five, and ten year summaries of site specific monitoring programs
- i. Complete model and annual monitoring reports and data analysis updates
- j. Implement feedback loops under peer and public review
- k. Plan and carry out a prioritized restoration program

- 3. Analyze historical and current riparian conditions to see if goals are being met
- 4. Develop a Macro-Watershed Analysis Procedure for forest-wide issues and restoration priorities
- 5. Design a Strategic Riparian and Aquatic Habitat Monitoring Plan with corrective actions, paying particular attention to criteria useful in trend analysis and riparian condition assessment
- 6. Organize a data distribution and update process for use by other agencies and oversight groups
- 7. Plan for public input within the process for changes in monitoring practices

B. A proposal for a Forest Plan Revision Timeline

- 1. A year and a half to complete all project reports already due from last ten years of projects
- 2. A half year for peer and public review of project reports
- 3. A three year Forest Plan Revision process which would require:
 - a. Historical and current condition assessment by the Forest Service and oversight groups
 - b. Public input and issue development
 - c. Draft EIS
 - d. Peer and public comment period
 - e. Final Revised Monitoring Plan for the Forest Plan

II. Issues Underlying Monitoring Objectives for the Forest Plan Revisions

A. What is the role of the public in monitoring programs for riparian health?

- 1. To insure that a revised Monitoring Plan incorporates necessary changes and feedback loops revealed by the first ten years of monitoring practices
- 2. To push for increased monitoring budgets or to redirect limited funds towards appropriate methodology to protect riparian beneficial uses
- 3. To demand that restoration be given its appropriate role as a management objective by pressuring for more accurate monitoring and assessment of current and historical instream conditions
- 4. To encourage monitoring designs which lead to increased local employment opportunities
- 5. To push for a monitoring plan that requires compliance to standards rather than being discretionary on the part of the Forest Service

B. What elements need to be addressed in a Strategic Monitoring Plan for Riparian and Aquatic Habitat?

1. What is the relationship between permanent long-term trend stations and project monitoring?
2. How can project monitoring be linked to KNF Forest Plan trend monitoring?
 - a. What is the best system of selecting representative and reference stream reaches for statistical analysis?
 - b. How can budget processes be set up to guarantee a sampling size large enough for statistical inference?
 - c. Can project monitoring be designed to build both baseline and trend monitoring?
 - d. If project monitoring reveals site specific problems, how does this feedback into changes in generalized Forest Plan management and monitoring objectives?
3. What can be accomplished in terms of validating KNF water yield projections?
 - a. What is the next step now that the CSU was unable to validate KNF water yield estimates?
 - b. KNF allowable peak flow increases were to be based on Channel Stability Ratings. Since the KNF has rejected CSRs as quantitative measures, what criteria should replace them as limits on management activity levels?
 - c. WATSED sediment predictions have been consistently inaccurate. What sediment model should replace it?
 - d. How should the "range of natural variability" be established and are elevated chronic levels of degradation, even if below extreme ranges, truly "acceptable"?
 - e. What are the best models to tie inchannel monitoring to timber harvest activity?
 - f. Is a Watershed Condition Assessment that includes qualitative as well as quantitative data a better measure of riparian health than current system of standards and guidelines and can it be tied to feedback loops that would alter management activity?
4. Should the streamside buffer zones, found to be much wider than Forest Plan or INFISH SMZs in a 1991 study on the KNF, be protected?
5. Which indices best reflect riparian health and which are most cost effective?
6. How can intensive post-flood monitoring, suggested by the ICBEMP, be funded and accomplished and what would be the feedback criteria to induce such forest-wide assessments?
7. How much do budget constraints restrict monitoring capabilities and what plan does the Forest Service propose to guarantee adequate instream assessments at the watershed level?

C. What are the computer and statistical requirements on analysis and design of monitoring variables and programs?

1. How can standardization be insured to improve statistical analysis?
2. How can a data distribution system be organized that would provide systematic updates for oversight organizations and other agencies?
3. Can a Web-site be established to ease riparian data access for outside organizations?

III. Steps towards Correcting Monitoring Failures under the KNF Forest Plan

A. Summarize historical and current conditions forest-wide before additional project planning

1. Need to compile historical analysis of cover type and age class, LWD accumulations based on stand data and reference reach data, and known degraded sites
2. Clarify the purpose of and difference between channel and streamflow classification, component condition mapping, and the monitoring of instream and riparian processes
3. Distinguish the differences and links between forest-wide trend and cumulative effects monitoring, project monitoring, and model validation monitoring
 - a. Establish which parameters have valid standards and which need monitoring to establish standards
 - b. Decide which parameters should be measured at each level (project, trend, model)

B. Develop and validate management models

1. KNF Water Yield - can it be validated and what variables should control allowable peak flow levels?
2. How can the sedimentation effects from harvesting be measured?
3. What other areas of research are needed?
 - a. Expand reference studies
 - b. Design baseline monitoring to tie into strategic trend monitoring
 - c. Continue independent research done the first ten years to improve statistical inference abilities through increasing sample size

C. Select monitoring variables and design an effective database structure

1. Use project monitoring to improve channel and streamflow classification
 - a. When doing watershed assessments for projects, map the entire drainage at one time, and classify by these three methods:
 - * Use actual measurements for Rosgen Channel Morphology Classifications
 - * Standardize and track KNF Riparian Classifications (streamflow) between districts
 - * Include INFISH Streamflow/Fish Habitat Classifications
 - b. Begin CSU-study recommended Pool/Streamflow Classifications and bank erosion length in projects as a means to quantify harvest-riparian condition relationships
2. Following major events such as high flow event of spring 1997 or fall/spring flood combinations, prepare plans for intensive forest-wide rapid stream assessments
 - * Record visible degradation points (project monitoring)
 - * Establish pool-infilling surveys in representative harvest and reference areas, focusing on degradation areas identified in projects (trend monitoring and identification of standards)
3. Select the following parameters as best measures, each with standards which induce Supervisor Office level policy reviews (feedback loops), mandatory restoration prioritization

reviews by the Districts (see below) and harvest limitation criteria (e.g. sale deferral; salvage only; no roadbuilding; selective harvest)

- a. Channel Stability Ratings - (initiate feedback when CSR > 90)
- b. Riffle Armor Stability Index - (initiate feedback when RSI > 75)
- c. Peak Monthly Flow Increases - (initiate feedback when PFI > 8%)
- d. Pool infilling rates and particle size distribution for representative reaches (standard - to be identified)
- e. Temperature - (initiate feedback when water temperatures reach > 59°F)
- f. Fish population studies - (initiate feedback when declines are documented)
- g. Macroinvertebrate studies - (initiate feedback when Mangun's Biotic Index < 85)
- h. Large Woody Debris size, location, and trapping ability - (feedback standard - to be identified)
- i. Post-BMP Risk Assessment - (initiate feedback when risk factor > 10%)

4. Map current and historical riparian components and conditions as a basis for watershed condition assessments and for determining trend and project monitoring needs

- a. Modify instream Pfankuch Channel Stability Inventories to improve utility by adding bank exposure per mile measurements; yet retain historical validity for trend monitoring (project monitoring - a rating > 90 induces a mandatory restoration prioritization review- see I. below)
- b. Analyze possible causes for degraded reaches found in CSR inventories, then map previous activity levels above problem areas for historical analysis (trend analysis)
- c. Measure and track LWD density by type and class per mile and recruitment tree potential (model validation monitoring)
- d. Measure open bank cut length per mile of representative reaches (model validation monitoring)
- e. Use GPS units to record pool and reach locations and degradation points (trend monitoring)
- f. Record and track all degradation points such as mass wasting sites, deteriorating road crossings, bridges, etc. (trend monitoring)
- g. Map actual and former SMZ widths to determine change over time (project and trend analysis)
- h. Map vegetative communities associated with riparian habitat including sensitive plant locations (project monitoring)
- i. Map and record fish presence and spawning redds (trend monitoring)

5. Develop efficient measures of instream processes and changes

- a. Continue channel cross sections and analyze annually with flow/discharge and sediment computer models (trend and model validation monitoring)
- b. Use Riffle Stability Armor Index for indication of bedload stability (project monitoring - > 75% bedload movement induces mandatory restoration prioritization review see I below)

- c. Measure water temperature variations throughout year (project monitoring - > 59° induces mandatory project deferral and restoration prioritization review - see I below)
 - d. Select a model for flow/discharge measurement evaluations and standardize its use (model validation monitoring and analysis)
 - e. Use project monitoring to establish pool infilling and particle size measurements (project and trend monitoring analysis)
 - f. Continue core sampling and embeddedness in spawning habitat (trend monitoring - > 20% fines should induce mandatory restoration prioritization review - see I below)
 - g. Continue macroinvertebrate sampling and use Rural Development moneys to establish a local lab for analysis of results (project and trend monitoring - Biotic Index below 85 or a drop > 10 within five year period should induce a feedback loop that requires a mandatory restoration prioritization review - see I below)
- 4. Prepare honest risk assessments for management activity
 - a. Continue BMP monitoring (project monitoring)
 - * Use risk assessment methodology that multiples effectiveness X implementation (10% risk maximum as a standard)
 - b. Reduce riparian and SMZ entry to as low a level as possible
 - 5. Prepare adequate GIS layers to respond to all data types (trend and model validation analysis)
- D. Standardize data collection procedures forest-wide
- 1. Standardize forms across the forest for classification, component, and process tracking and risk assessments
 - 2. Stick with forms for the full second ten-year program
 - 3. Allow additions to monitoring plan but require public and peer review for deletions
 - 4. Permit site specific exceptions following public input when tied to the Strategic Monitoring Plan
- E. Prioritize watershed and management activity
- 1. Analyze current data from all sources
 - 2. Prepare a restoration and recovery plan for the drainages whose assessments set them at the limit of Watershed Conditions or Peak Flow Increases
 - 3. Establish a process for analyzing riparian relationships to other forested areas, uses, and resources
 - 4. Include a budget plan to accomplish monitoring in the proposed Forest Plan Revisions
- F. Guarantee systematic and timely reporting of project, trend, and validation monitoring
- 1. Develop clear and concise reporting requirements for all projects
 - 2. Reveal analysis levels, responsibilities, and timelines in all project environmental assessments
 - 3. In Forest Plan, set up table of reporting frequencies for trend and validation monitoring
- G. Prepare summary analyses of monitoring programs
- 1. Prepare analyses at two, five, and ten year reporting frequencies for projects

- a. Address monitoring consistency and frequency success
 - b. Address summary findings as relate to goals and objectives of monitoring
 - c. Summarize findings in relationship to findings of other projects
 - d. Discuss errors, difficulties, and monitoring changes
 - e. Allow peer review and public review period and process
2. Prepare systematic trend reports on key trend and model validation monitoring
 - a. Analyze trends in instream monitoring results from trend stations and project monitoring
 - b. Analyze trends in meeting monitoring objectives and the initiation of feedback loops
 3. Analyze relationship of findings to beneficial use protection and Forest Plan management objectives
 - a. Were the monitoring objectives valid in light of the results?
 - b. Were the monitoring results valid in light of the objectives?
 - c. Were the results valid in terms of being scientifically justifiable and statistically valid?
 - d. Does monitoring reveal a trend of compliance with Forest Plan standards and guidelines?
 - e. What are the suggestions for a continuing monitoring program?
 - f. Do the results induce a feedback loop to change monitoring or management activity changes?
 4. Discuss further research needs
 - a. What can the Forest Service do with hydrology crews?
 - b. What research needs university or other institutional support?
 - c. Where can funding be obtained to carry out additional needed research?
- H. Complete the annual monitoring reports and distribute data updates
1. Make annual reports which contain specific project summaries and more data analysis
 2. Be on time and analyze Reporting Achievement from projects as a tracked Forest Plan Monitoring Item
 3. List available reports and summary for the public
 4. Provide FTP (computer/telephone) or Web-site updates of each year's monitoring data for the public
- I. Plan and carry out a Watershed Restoration Plan as part of the KNF Revised Forest Plan which:
1. Implements watershed restoration prioritization reviews (WRPR) as soon as problems are found
 - a. WRPRs will be initiated whenever: 1) any project monitoring finds reaches whose parameters fail standards; 2) any model predicts potential to fail standards; 3) mass wasting sites are discovered; 4) when trend monitoring and analysis reveal potential declines below standards or 5) when recovery plans demand it.
 - b. WRPRs will be open to public input and review

c. The contents of a WRPR shall include at least the following:

- a) A watershed analysis of the entire drainage (10,000 - 50,000 acres) in which the problem area is located
- b) A complete channel and streamflow classification and component condition mapping for the whole drainage
- c) An analysis of estimated pre-harvest conditions
- d) An historical analysis of management in the area and potential historical causes of the degradation site that is initiating the WRPR
- e) An analysis of appropriate reference locations and conditions
- f) A trend analysis that ties the specific problem parameter and its location to other project and trend monitoring of that parameter
- g) A Watershed Restoration Plan of Operations (WRPO) that addresses corrective measures for the specific problem site within the context of the entire watershed condition, including proposed restoration projects and how funding for them will be secured
- h) A Restoration Prioritization Rating (RPR) that places this restoration project within the context of other proposed projects, including an estimation of when the recovery project will be done

2. Prepares an annual Restoration Report (RR) which is tracked as a Forest Plan Monitoring Item

3 Joins with county and gives Forest Service financial development assistance to the formation of local watershed restoration committees for stream restoration projects

Appendix 6 A List of Findings and Recommendations of the CSU Study

MacDonald, Lee; Wohl, Ellen E. and Susan W. Madsen. 1997. "Final Report: Validation of Water Yield Thresholds on the Kootenai National Forest." Colorado State University, College of Natural Resources, Fort Collins

The Monitoring Process

- 1) Channel condition, which may have problems, is not the same as channel stability, which often is a problem;
- 2) The first step in assessing channel condition requires understanding processes of energy dissipation, sediment transport, and channel response;
- 3) The second step is identifying indicators of process, assess how process is affected by management activity, and understand how changes affect beneficial uses;
- 4) The third step is to measure the morphological characteristic;
- 5) The complexity of any quantitative cumulative effects model precludes true validation;
- 6) Reliance on qualitative data allows watershed to degrade before it is detected but acceptable quantitative methodology still has not been validated;

Streamflow and Water Yield Relationships

- 1) One must cut between 15% and 20% of a drainage before any hydrological consequences can be seen;
- 2) A study of investigations throughout the west reveal that Peak Flow Increases of 15% may be considered a common upper limit to achievable flow regardless of timber volume and not, as assumed by the Forest Plan Water Yield Model, the level at which degradation might begin;
- 3) The magnitude of peak flow increases does not correlate to the amount of timber harvest;
- 4) High intensity management is water yield increase > 11%
- 5) Only exposed bank in pool-riffle and colluvial step-pool is associated with increased discharge; all other indices are related to sediment supply increases;

Stream Channel Morphology and Sedimentation

- 1) Not all channels will have similar responses to changes in size and duration of peak flows;
- 2) In general, high peak flows should increase substrate particle size and channelization depth while increased sedimentation should decrease particle size and increase width/depth ratios, thus working in opposite directions;
- 3) Step-pool and pool-riffle channels were significantly different in gradient, bedform spacing, mean particle size in pools, and mean particle size in riffles;
- 4) The Rosgen classification system did not meet its own delineative criteria on the KNF and needs rigorous testing to be validated due to entrenchment and width/depth ratio discrepancies;
- 5) Different channels showed different responses to management
- 6) Low correlations between channel morphology and management indices makes it difficult to justify thresholds based on R1-WATSED predictions in water or sediment yield;

Flow and Sedimentation Relationships

- 1) Rosgen classifications are descriptive of channel type but not of instream processes;
- 2) Stream typing is more useful than channel typing;
- 3) It is difficult to separate changes in peak flow from changes in sediment supply and adverse effects usually result from changes in sediment rather than flow;
- 4) In colluvial and fluvial step-pool channel types, the ratio of predicted annual sediment increase to predicted annual water yield increase was best measure using WATSED RATIO analysis;
- 5) Pool-channels showed systematic increase to bank scour with increasing water yields which is not accounted for in WATSED modeling;

- 6) Upstream sediment storage may cause lack of correlation between harvest and downstream sediment monitoring;
- 7) The Pfankuch rating had a positive correlation with monthly peak water yield increase in pool-riffle channels;
- 8) Qualitative processes are bank erosion and sediment infilling while process rates include status of sediment storage;
- 9) It is suggested that a qualitative change occurs when predicted peak monthly water yield exceeds 6-8%; when predicted sediment yield exceeds 40-60%; or when predicted sediment yield increase is five times that of predicted water yield increase;

Natural Variation, Timber Harvest and Reference Data

- 2) Direct disturbance of stream channels or riparian zones by timber management greatly alters channel morphology;
- 2) That the lack of reference streams and reaches and the natural variability of rain-on-snow events between nearby streams makes quantitative predictability extremely difficult;
- 3) Locating unmanaged reference pool/riffle segments is difficult because they are associated with larger areas, almost all of which have been entered and previously harvested;
- 4) Drainage area, baseline runoff efficiency, gradient, bank material composition, and large woody debris accounted for a significant portion of variation in pool-riffle and set-pool areas;
- 5) Pool-riffle trends in managed areas include: increased bank cuts; slightly more undercutting; sediment deposits in over 50% of active channels; sediment traps full where no full traps exist in unmanaged reaches; infilling of voids likely; substrate material is loose; bright substrate particles;
- 6) Fluvial step-pools in managed areas had more bank exposed, sediment deposits on 20% of active channels, voids with sediment, sediment traps nearly full;

Recommendations

- 1) The Forest Service should find a means to adjust qualitative analysis with channel type;
- 2) The study clearly indicates that focus should be on particle size, particularly in pools;
downstream pools - % sediment fines; colluvial and pool-riffle - amount of exposed bank;
- 3) Recommended variables - location of exposed banks, extent of sediment deposits,
sediment trap capacity, and infilling of fine sediments;
- 4) The primary need is to design sediment budgets for catchments with areas of 10-20
square miles.