Summary of the Watershed-Landscape Analysis Workshop:

H.J. Andrews Experimental Forest

Blue River, Oregon
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Landscape analysis conducted at a watershed scale is emerging as a primary means of implementing ecosystem management, and is required under new regional conservation strategies, including the Northwest Forest Plan. The Watershed/Landscape Analysis Workshop held at the H.J. Andrews Experimental Forest in February, 1994, served as a reference point to evaluate recent thinking and examples of current watershed and landscape analyses. This report summarizes that workshop. Five current examples are presented and reviewed, representing various integrated assessments of terrestrial and aquatic functions. While specific issues, depth of analysis, degree of integration, and final products varied in each case, there is an emerging set of analysis, procedures, perspectives, and tools that future analysts can draw from. To be successful, watershed analyses will need to be technically credible, provide information to make better decisions on the ground, and work within an interagency framework, all within an arena of public expectations.

Keywords: Watershed analysis, landscape analysis, ecosystem management, FEMAT, landscape ecology, planning.

Contents

Introduction

The Watershed/Landscape Analysis Workshop was organized by the Cascade Center for Ecosystem Management in order to refine the understanding and application of watershed and landscape analysis. Specifically, the workshop moved forward toward the task of implementing watershed analysis (WA) on federal lands as directed in recent regional forest conservation strategies, such as the Scientific Analysis Team (SAT) report, the Forest Ecosystem Management Assessment Team (FEMAT) report, and the Supplemental Environmental Impact Statement (SEIS) of the President's Forest Plan. As a result, there is a bias in the organization, discussions, and conclusions within this document toward public lands in the westside Pacific Northwest.

The workshop centered around five examples of recent analyses from Oregon, Washington, and Alaska. Participants, representing private, state, and federal agencies, reviewed these case studies and synthesized the best ideas as advice for conducting future analyses. Questions and comments followed each presentation and the case studies were evaluated from the perspectives of integration, technical results, decision-making, and social concerns. Brief overviews of analyses in Northern California and the Rocky Mountains and a pulse conducted at the Mt. Hood National Forest broadened the discussion. Small working groups addressed questions specific to conducting watershed analysis.

The participants of the workshop included veterans of SAT, FEMAT, and WA, with experience ranging from the forest floor to the 13th floor. They shared a sense of urgency to advance the understanding of watershed analysis and to launch the pilot watersheds with the best advice available. They also shared a sense of gratitude toward the presenters who willingly offered their analyses "open kimono" to be measured and judged by entirely different objectives than those for which their work was designed. The discussions were at all times open and collaborative, demonstrating by example a cornerstone of WA.

In order to provide a framework for comparison, the speakers addressed a common set of questions in their presentations. The five written presentations in response to those questions form the backbone of this document. Despite our efforts at uniformity, the written presentations are quite variable in their level of technical detail and soul-searching retrospection. In each case, we have included a reference for a more balanced account of the analysis as performed. The published accounts we refer to will also include the references to literature cited in the text, which we have not duplicated here.

This document is not meant to be a full accounting of all that was said and done at the workshop. Rather, it is a blending of discussions recorded or overheard at various times throughout the three days—cut, spliced and presented as narrative. The document begins with a historic overview of watershed analysis, how we got to this point in the evolving process of WA. The presentations follow, providing examples of where we are now for evaluation and discussion. We have added a postscript that extends the workshop discussions to glimpse where we may be going with the pilot watershed analyses, and beyond to issues looming on the horizon.

Nor is this document meant to be a review of the *Federal Agency Guide for Pilot Watershed Analysis*. The federal guidebook, published concurrently with the workshop, was not available to participants in advance, and so was not a major part of the discussions. Another notable omission is the example of watershed analysis at Blowout Creek, an Integrated Resource Analysis recently completed on Oregon's Willamette National Forest. Conflicting schedules made it impossible for Blowout's principle participants to attend the workshop.

Executive Summary

Watershed analysis is an evolving process. Its roots reach back to cumulative effects analysis, through the FEMAT process, to the current pilot watersheds on federal lands. The Watershed/Landscape Analysis Workshop was the first effort to evaluate examples, not of textbook WA because none have been done, but of outstanding case studies of watershed and landscape analysis to find common points of agreement. Each presentation provided examples from which to draw for future analyses; and yet each was different enough to demonstrate that watershed analysis (WA) is a flexible, experimental process, designed to address specific issues in each watershed. Most important, the workshop encouraged the initiation of pilot watershed analyses, despite uncertainty, by the example of experience and in the spirit of adaptive experimentation.

Points of agreement

All five of the examples presented were initiated prior to FEMAT, and demonstrate that WA is consistent with existing planning processes within federal and state agencies. Each was conducted with available techniques and specialists, requiring no extensive retooling.

Foremost among the points of agreement is that watershed analysis is a vehicle for ecosystem management at a watershed scale. As such, it must include an integrated assessment of terrestrial and aquatic functions from channel to ridgetop, a description of current condition, and a synthesis of desired future condition.

In the short term, WA will be used to defend or modify riparian reserve boundaries, based on an analysis of ecological function and comparing levels of protection to maintain ecological function. In the long term, the need for reserves may fade if management decisions are based on achieving desired future conditions established by WA. But WA is not a decision-making process for federal land-managing agencies. It provides decision-makers with a scientific assessment of processes within and surrounding a watershed in order to support planning.

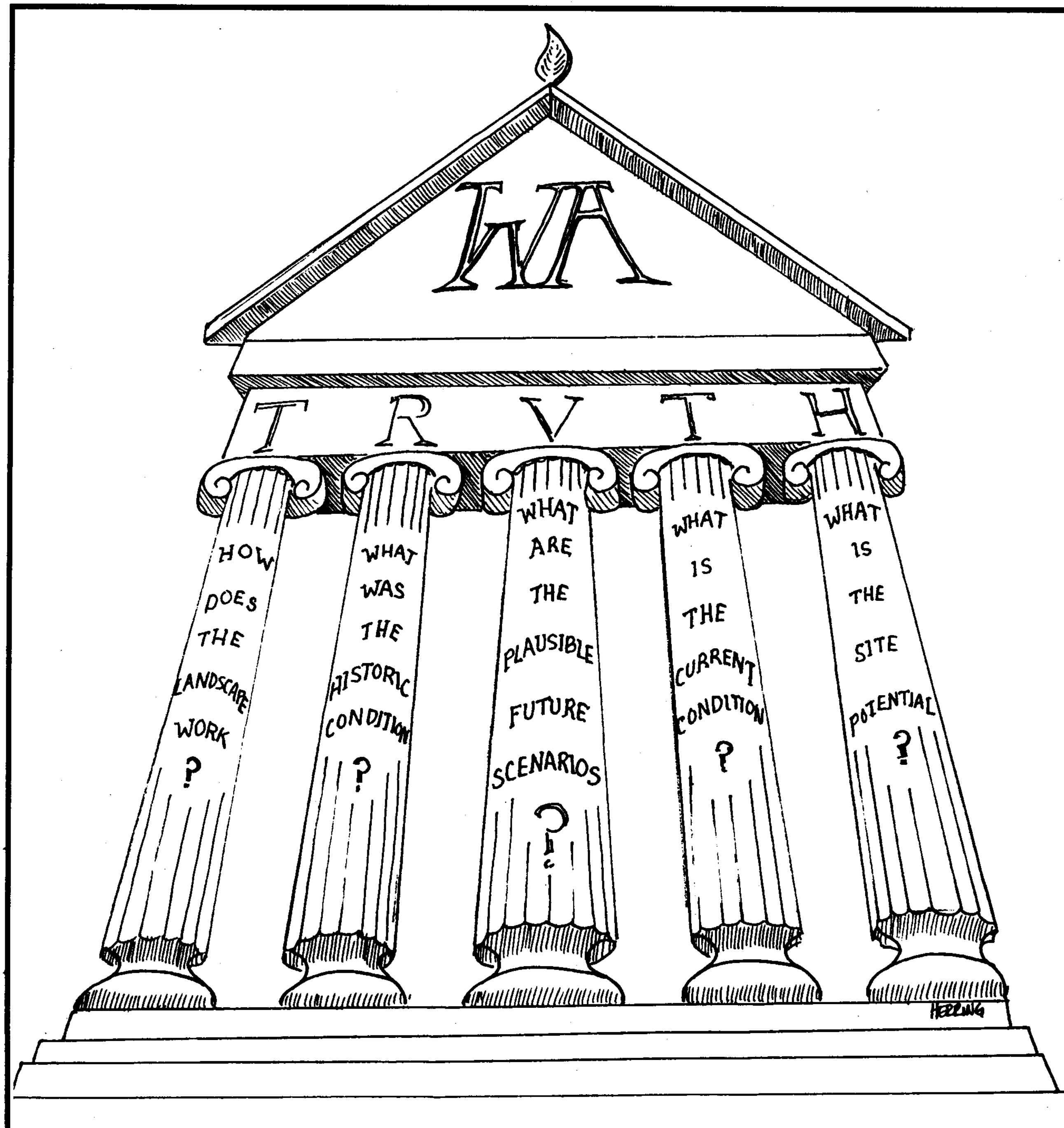
Watershed analysis should always be set in the context of larger landscapes (basins, provinces, regions) in order to coordinate with regional strategies of management and restoration, and to integrate large-scale processes that may be difficult to measure at a watershed scale. Similarly, a watershed analysis should include a level of detail that is meaningful to smaller scale projects and site-specific issues. Social and economic assessments, conducted at multiple scales (local, regional, national, global) should be integrated into the analysis.

Watershed analysis has come on board with promises, and with problems. Although the social component was recognized as important to the analysis, none of the examples demonstrated a coherent social assessment. Public participation will be difficult to solicit if there is no decision space available to debate. Decision-making itself remains a gray area between watershed analysis as a tool and the ecosystem management it is meant to support. And finally, the technical merit of these analyses has yet to be systematically reviewed.

However, none of these problems are large enough to derail the process of watershed analysis as a vehicle for planning. The pilot watersheds provide the opportunity to apply what we have learned and to address these questions. Watershed analysis is an iterative, adaptive process that requires experimentation to proceed.

Watershed/Landscape Analysis Workshop

Introduction to Watershed Analysis



Pillars of WA

Introduction to Watershed Analysis—a Retrospective

Gordon Grant
PNW Research Station

This workshop was organized as a sort of bootstrapping exercise to examine examples of watershed and landscape analysis and learn what works, what doesn't, and what can be done better in the future. The products of this workshop are advice, recommendations, critique, and evaluation of what has been—all with an eye to improving the process of watershed analysis (WA).

To begin, watershed analysis is not an original idea. The notion that we ought to know something about landscapes before we start changing them reaches back at least as far as the ancient Chinese art of geomancy—siting buildings so that the gods smile propitiously on them and they don't fall down. More recently, the roots of watershed analysis can be found in the writings of certain conservationists—John Powell, Clarence King, Gifford Pinchot—who expressed the notion that the landscape is to be understood and human actions should be designed with that understanding in mind.

From these writings grew the concept that a watershed represents a reasonable and relevant demarcation of the landscape for land-use planning. The Tennessee Valley Authority and other early river basin planning strategies provide experience as important as the more recent examples we discussed at this workshop. If we look at the TVA, we see an important idea opposed by those who viewed it as unwarranted government interventionism in private affairs. We need to consider that experience when we consider the brave new world of watershed planning and management in which we are now engaged.

The concept of watershed analysis is closely related to the issue of cumulative effects. For several decades, we have grappled with how land use activities on federal, state, and private lands interact to affect hydrologic and ecologic processes. Many of our current problems—endangered species, declining salmon populations, forest fragmentation—are evidence of our inability to deal effectively with cumulative effects. In a sense, watershed analysis has evolved as a kind of proactive analysis of cumulative effects, conducted prior to developing management plans rather than in response to predetermined action.

Historians talk about ideas emerging simultaneously in different places. A document of our current phase of history would note that the idea to use watersheds as units of planning and analysis has evolved in many government and private agencies seemingly independently. But the process may not have been truly independent, but rather, in a Biblical paraphrasing, a story of begats: emerging from the waters churned by state and local resource planning came PACFISH; PACFISH begat SAT; SAT begat FEMAT; FEMAT begat WA. Of course, the real story is neither linear nor predestined toward federal redemption.

Ideas have evolved through the process. Yet, the basic concept has remained that watershed analysis is a mechanism to address inconsistencies between the current scales of planning and the direction to implement ecosystem management. These inconsistencies arise on Forest Service lands, for example, as Congress sets both the commodity output levels, through specified timber targets, and environmental direction, through legislation such as NEPA and NFMA. Forest Plans attempt to implement these targets and direction. As we know, the courts have found that the commodity outputs and environmental direction are fundamentally incompatible, and Forest Plans have been challenged as inadequate.

Attempts at regional-scale conservation of owls, salmon, old-growth and various species, required that landscape planning and management be more spatially explicit at scales such as physiographic provinces, river basins, and watersheds. Regional scale conservation strategies, such as PACFISH or FEMAT, called for landscape or watershed analysis as a way of focusing conservation strategies to specific landscapes.

So watershed analysis presents a very simple idea, that a comprehensive and systematic analysis of a landscape can and should inform landscape management. Originally conceived as a method to tailor riparian management, WA

figure 1

Objectives of Watershed Analysis
(in increasing order of complexity)

- Provide information to guide planning and management
- Guide restoration and monitoring activities
- Analyze cumulative effects
- Establish geomorphically and ecologically appropriate riparian reserves
- Provide a common framework for evaluating and managing upland and riparian landscapes
- Provide a common framework for multi-agency, multi-user interactions

has quickly broadened (theoretically, at least) to address a full range of terrestrial and social objectives as well. The current expectation for watershed analysis is that it will do more than develop effective riparian reserves; it will provide the analytical framework to accomplish landscape design.

As many of you who participated in FEMAT and some of the other regional conservation strategies know, the integration of terrestrial and riparian issues, as well as social expectations, has proven difficult. In addition to its technical application, WA is expected to be an interagency process and forum. It is expected to involve the public in some way not yet fully understood. Management activities will be placed in the context of variability of historical disturbance regimes. And there is a great deal of uncertainty as to how planning is going to proceed in the face of what looks like a reconstituted planning universe.

Beyond all these expectations for WA is the big question: how do we use the information from watershed analysis to make better land-use decisions? WA was developed to meet a specific set of objectives (Figure 1) that reflects many of the dominant issues that we face in the months and years ahead. The political context in which watershed analysis has emerged establishes new benchmarks against which watershed analysis will be judged, rightly or wrongly. There is not only the legal mandate to analyze cumulative effects, an issue that watershed analysis intrinsically addresses, there are also legal requirements imposed by the Endangered Species Act and other legislation to design protection schemes for riparian and other organisms. Unless we can reach agreement about how we, as a community of scientists, managers, and the larger public, use WA to design effective environmental protection, then WA will never acheive its potential.

Some of the most challenging objectives of WA are also the most exciting. Watershed analysis could provide a common framework for evaluating, planning, and managing watersheds. It could carry us beyond defining protection schemes to designing landscapes to meet varying objectives. Perhaps the most ambitious goal of WA is to serve as a basis for interagency and multi-user interactions and agreements regarding land-use decisions.

figure 2

Pillars of WA

- How does this landscape work?
- What was the historic condition?
- What is the current condition?
- What is the site potential?
- What are the plausible future scenarios?

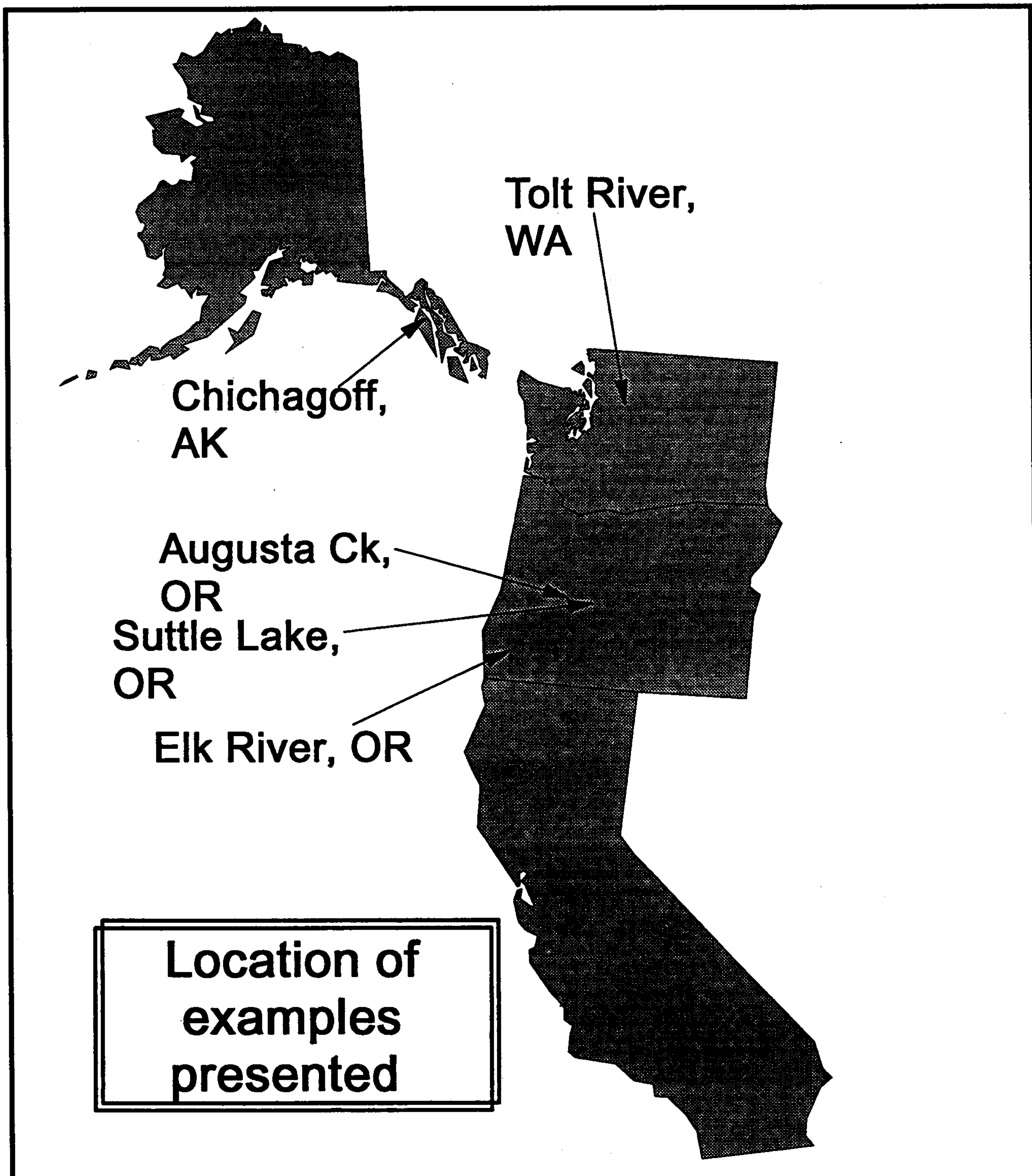
How do we do watershed analysis? What is the technical framework, sequence of tasks, relationship with planning? The examples presented at the workshop represent a number of different approaches emphasizing different objectives driving land-use/landscape planning. Most stratify the landscape into analysis units, and then examine how watershed and ecosystem processes are distributed through these units. Most of the examples follow the analysis with a synthesis of individual components that connects the landscape units into a blueprint to guide management activities.

How will we evaluate these examples? One reference point may be to ask how well each addressed a set of key questions—the pillars of WA (Figure 2). A fundamental product of WA is an analysis of landscape process, condition, structure, and change that allows us to determine what human activities are fundamentally incompatible with that landscape.

In conclusion, we see there are some salient historical issues that brought us to this juncture. These case studies represent different fledgling approaches to a complex problem. They come from different landscapes with different objectives, they had different players involved, they were funded to different degrees, they have different institutional investments behind them, and they have different outcomes and products attached to them. It will be interesting to see how well we can compare, contrast, and glean useful information from them. Along the way, we may learn something equally important: how to learn from each other.

Watershed/Landscape Analysis Workshop

Presentations



Watershed/Landscape Analysis Workshop

Case Study Comparison Matrix

The purpose of this matrix is to guide readers to examples of analyses that included particular topics, noted with the indicator "x". The relative quality of these analyses is not implied by the presence indicator, however, we did attempt to identify case studies which we felt dealt with each topic most comprehensively (+). Please note, this matrix is based on information available at this time.

	Tolt River	Suttle Lake	Augusta Creek	Elk River	Chicagof Island
Analysis Modules					
Existing vegetation		x	x		+
Potential vegetation		x	+		x
Landscape pattern		x	+		x
Plant species of concern			x		+
Historic disturbance patterns		x	+		x
Human settlement and management			+		x
Blowdown					+
Roads	x	x	x	+	x
Erosion & sedimentation	x		x	+	x
Runoff	x		x	+	x
Channel condition	x	x	x	+	x
Aquatic biology	x			+	x
Wildlife habitat		x	x		+
Water temperature	x		x	+	
Domestic water supply	x				
Social assessment					
Analysis Process					
Public participation	+	x	x	x	x
Link to larger scales		x			+
Link to projects	x	+	+	x	
Include multiple ownerships	+	x		x	x
Aquatic and terrestrial integration		+	x		x
Projection of future mgt. & conditions		x	+	x	
Analysis Products					
Identify restoration projects	?	x	x	+	
Define riparian reserves	?		x	x	
Develop desired conditions		x	+		

NOTE: Analysis modules are from the *Handbook for Pilot Watershed Analysis*. The Augusta Creek, Elk River, and Chichagof Island analyses are ongoing and will undoubtedly address more of these topics in the near future.

Watershed/Landscape Analysis Workshop

Presenters' Organizing Questions

Each study presented at the workshop was developed to address a unique set of conditions; none were designed specifically as watershed analysis, *per se*. In order to find common ground among these disparate examples, we asked the presenters to use the following questions to organize their presentations.

These are not the questions they used to conduct their analyses, and we were not looking for a perfect score. We wanted to know what worked, what didn't, and what advice they would have for those who are planning the next round of watershed analyses.

I. Objectives and Purpose

1. What were the objectives of this analysis?
2. What was the overall planning strategy? How does this analysis relate to other plans at other levels?
3. What objectives, limitations, or constraints from higher order plans were used to direct the analysis? How specific was the direction?
4. What was the role of the public?

II. Analysis Process

1. What was the overall analysis strategy?
2. What were the key assumptions?
3. What kinds of information were used? How much did you use new information, compared to existing information?
4. What ecosystem processes or conditions did you analyze? How did you decide which ones to include?
5. What were the analysis methods?
6. What spatial scales did you include in your analysis? How did you consider conditions outside your study area?
7. What time scales did you include in your analysis? Did you use historical records?
8. How were conditions on adjacent lands considered?
9. Did you include private lands in your analysis? If so, what data were available and what assumptions were made about future activities on these lands?
10. How did you integrate terrestrial and aquatic concerns within the analysis?

III. Products and Results

1. What were the products of the analysis? (maps? management guidelines? reserve delineations? etc.)
2. How did you display the results?
3. Did the analysis result in a description of desired future conditions? At what level of specificity?
4. Did you identify a reserve system to protect aquatic resources and ecosystems? If so, how?
5. Did you identify a reserve system to protect terrestrial wildlife or late-successional species? If so, how?
6. How were results integrated? (e.g.. transportation network and hydrology?)
7. Did the results from the analysis help set objectives at stand/site/ project scales? In what ways?
8. How were the results of the analysis made available to forest managers?
9. To what extent were the recommendations of the analysis actually implemented?

IV. Logistics

1. What skills, disciplines, time, tools, and funds were required to conduct the analysis?

V. Conclusions

1. What would you do the same or differently next time?
2. What advice do you have for those people who are launching new watershed/landscape analyses?

Watershed/Landscape Analysis Workshop
Tolt River Analysis

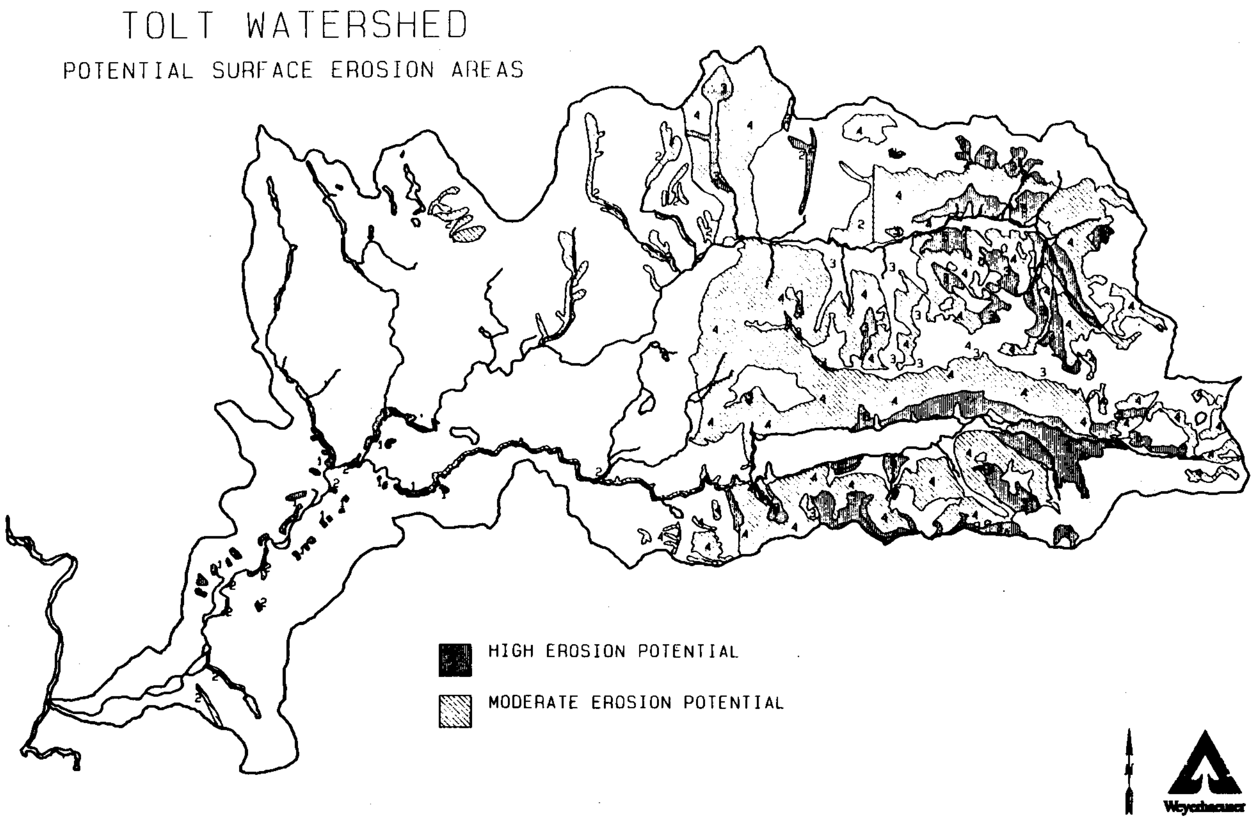


figure 4

Tolt River Analysis

Kate Sullivan
Weyerhaeuser Co.

I. Objectives

Introduction

In recent years, the Washington Forest Practices Board has been called on to review state forest practices in terms of their cumulative watershed effects. Part of this effort included the organization of the Timber/Fish/Wildlife (TFW) Agreement whose cooperators include the state Departments of Natural Resources, Fisheries, Wildlife, and Ecology, tribes, forest products industries, private landowners, and environmental groups. TFW recommended a process to develop a forest practices plan tailored to each watershed and based on scientific understanding. This process, as encoded into state administration and described in the Watershed Analysis Manual, was adopted by the Forest Practices Board in 1992 and is administered by the Department of Natural Resources (DNR).

This DNR watershed analysis defines areas of sensitivity within each watershed with explicit consideration of resource vulnerabilities based on the potential risk of specific impacts on public resources. Out of nearly 400 newly-designated Watershed Administration Units (WAU) identified throughout the state, Tolt River was one of the first watersheds to be analyzed using the new process. The Tolt analysis followed guidelines outlined in the compiled by representatives of TFW and DNR for the Washington Forest Practices Board. The Watershed Analysis Manual provides a step-by-step approach for conducting the analysis from resource assessment through risk and sensitivity analysis to management prescriptions. The manual also includes guidelines for monitoring effectiveness, which is included in the process as a voluntary activity, dependent on time and budget, and not required by law.

The 65,000-acre Tolt River watershed is located on the west slope of the Cascades, east of Seatttle. The upper watershed consists of steep slopes formed on a variety of resistant rock; the lower watershed is relatively flat as the river incises through deep glacial tills. The watershed supplies one third of Seattle's water supply, and also supports a threatened run of summer steelhead. The city of Carnation lies on the flood plain of the Tolt at its junction with the Snoqualmie River. Weyhaeuser is the largest landowner (60%) among the mix of ownerships, which also includes the City of Seattle, the USFS Mt. Baker-Snoqualmie National Forest, the Washington DNR, and several small private landowners. Land use is varied; Weyhaeuser and DNR lands are primarily managed for timber; City of Seattle lands are managed for water quality. These lands have been previously harvested, and portions of the watershed are currently being harvested for the second time. Most of the USFS ownership in the headwaters is old growth.

The TFW Model

The DNR watershed analysis method emphasizes geomorphic changes to aquatic habitats, water quality, or public water supply. Upslope processes are linked to stream-related resources by the flow of sediment, water, debris, and energy that effect the stream environment. In order to determine the level of risk of a potential hazard, a link is made between the resource and the impacting mechanism.

The fundamental assumption in the TFW model is that by applying standard forest practices in less sensitive areas and tailoring appropriate restrictions in sensitive areas, the overall watershed condition will be protected and cumulative effects will not occur. The scientific assessment identifies the sensitive areas that require special management prescriptions. Once the sensitivities are identified in relation to types or rates of activities, the prescription process tailors activities to solve existing problems or to address the risk of creating new problems. The two tasks—resource assessment and prescription design—are separate, conducted by separate teams of professionals. Integrated planning results when the scientists who develop the assessment work collaboratively with managers, as advisors to the development and implementation of the plan.

The TFW model begins by notifying all landowners and other interested parties within the watershed and scoping their concerns. These stakeholders are included throughout the process. All available data, maps, and photographs are collected, working teams are formed, and the resource assessment team develops a plan for conducting the required evaluations of the watershed.

Once underway, the resource assessment follows two phases. First, in the inventory phase, analysts work relatively independently collecting data and interpreting specific processes. Second, during the synthesis stage, analysts work together to develop causal mechanism reports, a watershed-scale storyline of cause-and-effect links between hill slope and stream.

The prescription process follows the assessment summarized in the causal mechanism report. For each site, a team of managers and analysts prescribes strategies to avoid, prevent, or minimize problems.

A final step includes synthesis of a summary report with prescriptions attached to each resource sensitivity identified in the causal mechanism report. The writing process is streamlined by the use of data forms and worksheets provided in the manual (Figure 5).

II. Analysis Process

The Tolt River analysis was conducted from January to May, 1993, as an "event" process to identify problems and to develop a plan for the Tolt watershed. It involved 50 people (although only about ten would be required)–scientists, managers, private landowners, all-comers–in developing a plan to refine state forest practice regulations specific to the watershed. Following the TFW model, watershed analysis is a planning process. The objectives were to identify all areas sensitive to forest practices; develop an understanding of causal mechanisms and the practices that trigger them; understand linkage to public resources; and develop general management plans for addressing sensitivities. The overriding premise was that management (timber harvest and roading) will happen, and the purpose of the analysis was to design management plans to address potential problems.

Central to the Tolt analysis is the assumption that by addressing problems related to the spatial variability of watershed processes and sensitivity of forest practices to them, concerns over cumulative effects can be mitigated through a strategy of preventing, avoiding, or timing certain forest practice activities. Resource stakeholders (including tribes, environmental groups, agencies, landowners) played a key role in developing the framework for analysis process.

The analysis strategy was in four parts:

- scientific assessment is conducted
- prescription team responds to assessment
- monitoring program is devised
- public comment is sought

The scientific assessment began by gathering existing information regarding soils, geology, topography, fish habitat, riparian processes, hydrology, water quality, survey data, map layers, aerial photos, past assessments, anecdotal information, etc. The assessment team also generated a great deal of information on their own. Most decisions made by the prescription team were based on new information or on new interpretations of existing data developed by the assessment team. Noticeably absent were assessments of wildlife habitat, modules currently under development for future TFW analyses.

The list of watershed processes and conditions to be included in the assessment was built through public dialogue, as well as recognition of legal responsibilities and a consideration of key processes that drive the system. The list of modules guided individual in-depth assessments to rank the severity of problems for management consideration. The comprehensive list of modules outlined in the TFW Watershed Analysis Manual provide direction and limits to the analysis, streamlining the process considerably.

A range of spatial scales were used, as appropriate for understanding the variables in a process; usually 10-full watershed acres. The assessment considered all ownerships within the watershed. Time scales were equally broad. We considered the geologic history of the watershed and the indefinite future of the watershed by considering probable trend lines over no specific time frame. Aerial photography from about the 1930s provided a recent history of land use and changes within the watershed.

III. Products and Results

Individual assessments were synthesized into a watershed "story" to establish the cause and effect of forest practices and watershed processes as a "line of evidence". These causal mechanism reports identified uncertainty and strengths in the analysis and guided the writing of prescriptions with a risk assessment matrix drawn for every site and module within the watershed.

Other products included maps, science reports (data and narrative and forms), prescriptions, and optional monitoring plans. The Tolt analysis generated about 25 maps, seven boxes of data, and two notebooks full of reports. However, a digestible summary report for outside reviewers has yet to be produced.

The analysis did not explicitly result in a description of desired future condition nor an identified riparian reserve system. We had a few sites on private land where no action was possible because of extreme sensitivity and riparian areas were expanded, but not specified as "reserves." USFS land in the watershed will be a "reserve." As for terrestrial reserves, we had previously identified protected areas for wildlife species (goats, eagles, owls) which remained in the plan.

The results from the analysis provided very specific objectives for each identified management unit. The results were made available to forest managers through the causal mechanism reports (written) and by direct hand-off (verbal). Scientists from the assessment team briefed managers and reviewed subsequent decisions made by managers. The managers "own" the plan because they developed it. The recommendations were accepted 100% and actions are already well underway.

IV. Logistics

The Tolt River analysis used everyone at all levels of educational background and skills. Disciplines included geomorphology, hydrology, geology, engineering, fisheries biologists, water quality, forest engineering, harvesting engineers, foresters, and probably more. The entire analysis, including public review, was complete in five months. Our costs were approximately $3/acre, probable total costs were approximately $5/acre. We believe approximately $2/acre may be needed for basic analysis.

V. Conclusions

What would we do next time that would be different? We would do a better job of organizing and informing players up front and better job of group facilitation. In the spirit of experimentation, we are always working for better ways to assess watershed processes and forest practices. We felt that the analysis was good and the information extremely useful.

Watershed Analysis Manual *Synthesis*

An Example from the Tolt River - Causal Mechanism Report

Form 4. Causal Mechanism Report Summary

WAU: *TOLT*

Resource Sensitivity Number:
Mass Wasting Hazard Unit #1

Situation Sentence:
Coarse and fine sediment from past landslides in Unit #1 associated with roads and timber harvest within inner gorges has reduced pools and degraded cutthroat (and possibly dolly varden and bulltrout) spawning, and summer and winter rearing habitat in the North Fork braided reaches (Segments 13, 15, and 17). Sediment from this unit is also routed downstream and can affect depositional areas such as segments 1, 2, 3 and 5.

Triggering Mechanism(s) (Be as precise as possible):
Failures are mainly associated with roads, both sidecast failures and fill failures. Stream crossing failures are the result of the active transport of wood debris and bedload down these channels, causing plugged culverts. Harvest of the very steep slopes adjacent to streams has accelerated mass wasting. This is due to root strength deterioration and changes in groundwater hydrology. The larger melt rates and volumes due to clearcut harvest may lead to an increase in saturated thickness causing failure. Given the elevation and rock type, root strength is the more important of the two.

Rule Call for Management Response:
Prevent or Avoid

Additional Comments:
Dolly varden and rainbow may be present. Unit #1 is a naturally unstable area. Delivery associated with Segments 13, 15 and 17.

figure 5

Tolt River evaluation

kudos

• it was an open process and involved all landowners (public and private) from the beginning
• the inclusion of all stakeholders brought all issues to the table from the beginning
• this provided a feeling of ownership to all participants which helped to streamline the public review
• all participants knew the "rules" from the beginning (methods and guidelines outlined in the manual)
• the analysis was built along a logical "line of evidence"
• strict time frame forced the process forward
• it distinguished between resource assessment and prescriptions, separating them as distinct tasks done by separate teams
• although analysts did not write the prescriptions, they were involved in the review of prescriptions
• established a "story line" between cause and effect (through causal mechanisms reports) for managers
• used placeholders for components missing from the analysis so that the process did not stagnate
• the methods were designed to be modified and updated, while the concept of watershed analysis remained constant
• this flexibility allowed an evolution of hypotheses through evaluation and feedback
• provided direction to decisions made at a site level
• this analytical process has been field-tested several times

critiques

• risk management may promise too much
• need linkages to higher scales
• unusual events were not adequately considered over a broad range of time and spatial scales
• it is not clear how this process applies to lands not explicitly managed for timber
• this analysis may not support decisions to resolve incompatible management objectives
• this analysis has no summary documentation, only volumes of background information, and so it is difficult to evaluate and build upon
• archived information needs to be accessible and comparable to other ongoing and future analyses (through GIS, for example)
• monitoring and feedback to management needs to be hardwired into the process
• the concept of social values should be expanded beyond that of bridges and roads

considerations

• it used a manual—not a cookbook—to guide this and subsequent analyses
• analysis was accomplished without a GIS or high-tech accompaniment

Tolt River analysis summary

Understanding the Tolt River watershed analysis requires understanding its context. Of the five examples summarized here, the Tolt River WA is the only one that was conducted explicitly as a watershed analysis. It is also the only example that deals primarily with non-federal lands. The Timber, Fish and Wildlife (TFW) consortium has spent several years developing a process for watershed analysis which incorporates multiple landowners and agencies, involves the public directly and openly, and has an established set of procedures contained within a published guide.

It also has the institutional blessing of the State of Washington, which has formally adopted the TFW process for watershed analysis as part of its regulations governing forest practices. The Tolt River WA therefore represents an early example of an accepted and codified process designed to meet specific objectives on mixed ownership lands.

Those wishing to apply the Tolt River analysis to Federal or other mixed-ownership lands should understand those objectives as well. First, an overriding assumption in the Tolt analysis was that commercial timber cutting would occur with no assumption of actual volume. Second, the primary objective of the analysis was to arrive at a good enough understanding of how the landscape functioned to determine where appropriate forest management practices would be applied without unduly increasing risks of landsliding, channel changes, or damage to fish and riparian vegetation. The analysis functioned primarily as a refined evaluation of the potential for individual and cumulative effects of timber harvest and related activities. It did not attempt to define a desired future condition for the basin as a whole, but did provide guidance and direction for writing management prescriptions for specific parts of the landscape. Because the Tolt River process was voluntary, a third objective was to encourage all the landowners in a basin to participate willingly and openly.

Given these objectives, the Tolt River process worked well in many respects. It was particularly effective in engaging the public early and earnestly in both crafting the process and validating the results of the analysis. The results of the analysis were cast in terms of narrative, clear statements of causal mechanisms, and specific guidance to land managers, who were given independent responsibility to develop prescriptions based on the analysis. Analysts then reviewed the plans and prescriptions (although it was not clear how this review was organized or conducted). Although the analysis was somewhat limited in scope, focussing primarily on geomorphic and hydrologic processes, the technical framework itself appeared sound.

A comprehensive review of the Tolt approach is limited by the opaqueness of many of the most important details. There is no single, clear summary of results, only a daunting collection of raw data. The inherent ambiguity of terms such as 'high, medium, and low risk' and 'prevent or avoid' prescriptions make it difficult to assess how much risk is actually being assumed by the resource analysts and managers (although it may be argued that a more explicit risk assessment cannot be justified). The overriding assumption of commercial harvest, no assumption of ecological reserves, lack of analysis of wildlife and other ecological processes, and uncertainty as to what role the Tolt watershed plays in the larger regional context, are also issues that would need to be addressed before applying the Tolt process on Federal lands, although the process may be adaptable.

In sum, the Tolt represents an excellent example of watershed analysis actually implemented in a contentious, multi-owner landscape and a robust process that can mature with time.

Watershed/Landscape Analysis Workshop
Suttle Basin Analysis

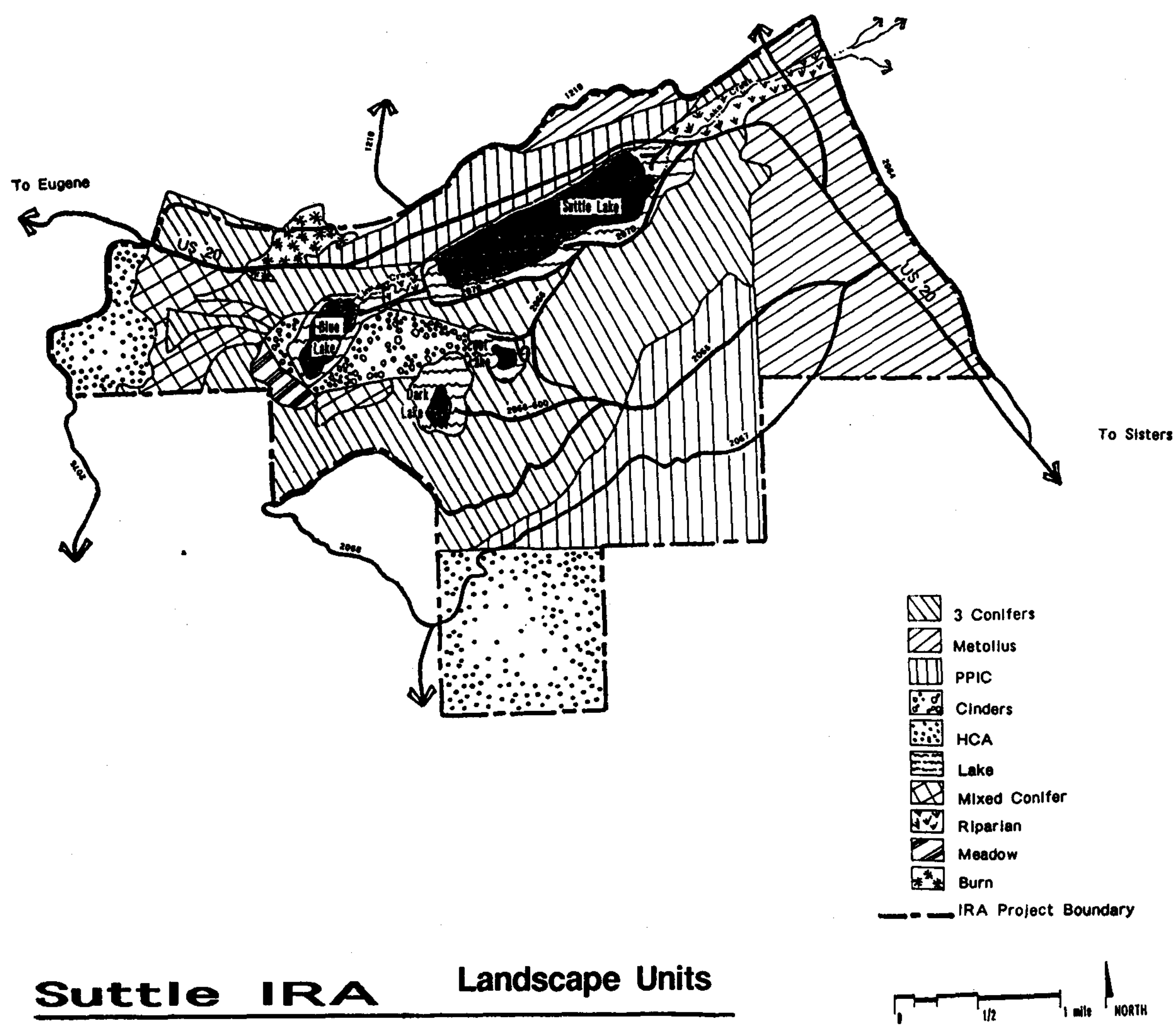


figure 6

Suttle Basin
Integrated Resource Analysis

Jennifer Burns
Deschutes National Forest, Oregon

I. Objectives

The 6600+ acre Suttle Lake area was selected as the focus for the Sisters Ranger District's first IRA because it presented a high profile example of the forest health issues at Sisters and elsewhere east of the Cascade Range. In addition to containing the US Highway 20 scenic corridor — one of the main travel routes between Central Oregon and the Willamette Valley — the Suttle area hosts more than 140,000 visitors a year in its campgrounds, as well as providing recreation opportunities through resorts and church camps. The goal of the planning effort was to take a comprehensive look at the ecological conditions in the Suttle Basin area. This assessment would provide a foundation from which a plan of action for management in the area could be developed.

The planning strategy for the Suttle IRA followed a framework described by Nancy Diaz and Dean Apostol in their book, *Forest Landscape Analysis and Design*. The eight step process takes planners through an analysis phase and a design phase (Figure 7). This method asks the resource planners to understand the landscape as an ecological system by identifying and describing its structures (the physical, tangible elements we can touch and see); its functions (activities, roles, and processes); its natural patterns of disturbance (fire, insect, disease); and its relationships or, linkages, to other ecosystems.

As a result of the analysis the landscape was "zoned" into landscape units that represent areas of similar environmental attributes or function. Landscape objectives were identified for each landscape unit, derived from public concerns, Forest Plan direction, larger conservation strategies (i.e.: owl and eagle objectives), resource conditions, etc. Objectives should describe what landscape processes and structures should be emphasized. Desired future landscape conditions should be described based largely on these objectives.

When compared with the current condition, the target conditions suggest the kinds of projects necessary to achieve ecological and management goals. The target

ANALYSIS PHASE

STEP 1 - **Landscape Elements** - Identify, map and describe the elements of the landscape (patches, corridors, matrix), and the landscape pattern.

STEP 2 - **Landscape Flows** - Identify and map landscape flows of interest or concern.

STEP 3 - **Relation between Landscape Elements and Flows** - Describe the interaction between elements/pattern and flows, to facilitate understanding of the functional aspects of the landscape.

STEP 4 - **Natural Disturbances and Succession** - Describe how natural disturbances and successional process operate in the landscape, and how they affect and are affected by landscape patterns

STEP 5 - **Linkages** - Describe functional linkages to adjacent areas.

DESIGN PHASE

Establish objectives:

STEP 6 - **Landscape Patterns from the Forest Plan** - Determine what landscape pattern objectives already exist, from the Forest Plan.

STEP 7 - **Landscape Pattern Objectives (Narrative)** - Develop statements that describe the "target" landscape pattern (kinds, shapes, sizes, arrangement of landscape structures) in different parts of the planning area, using information from Steps 1-5 (Analysis Phase), Step 6, and local resource objectives specific to the analysis area.

Spatial design:

STEP 8 **Forest Landscape Design** - Using landform analysis and spatial design techniques, map the areas of the landscape within which a particular landscape pattern is desired, based on the objective statements from Step 7.

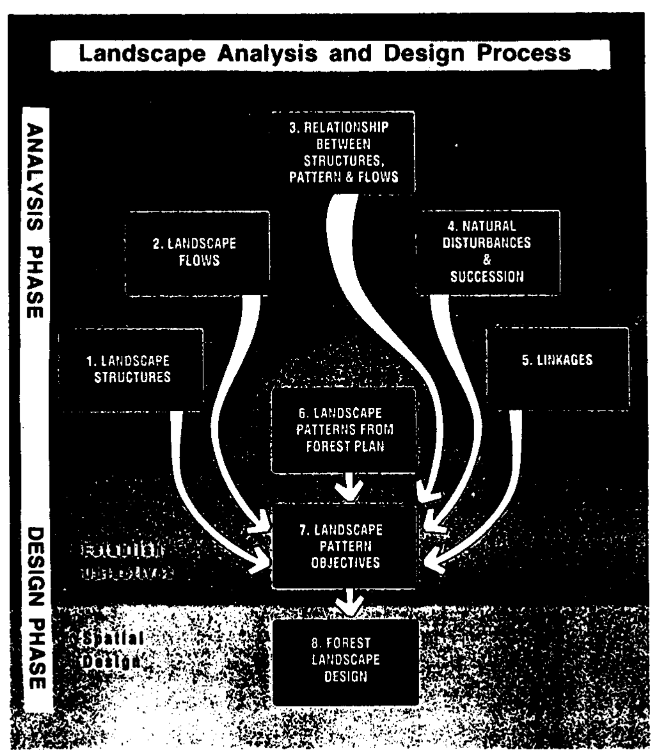


figure 7 (from Diaz and Apostol 1992)

conditions should be geographically based and guide where on the landscape these particular projects belong in order to maintain that larger picture.

The planning process generated a list of site-specific projects that are consistent with ecological and social goals, and that fit within the context of the larger landscape strategy. The IRA was not a decision document. Project specific analysis and decisions are the next step in management.

The analysis was not constrained by higher order plans or objectives as much as it was focused by resource issues, public perceptions of forest health and funding. I.e.: the team took a very holistic., albeit scientific, view of the planning area, spending approximately equal amount of effort in each resource area. The Habitat Conservation Area west of the planning area did constrain the planning boundaries. Although this area was ecologically connected, it was not included within the analysis because of the legal constraints on vegetation management. In addition, the planning area did not overlap onto the Willamette National Forest because the common boundary area is predominately Wilderness and HCA.

Role Of The Public

The public played an advisory role. They were not directly involved with the analysis or the design process. The public was asked for information about the planning area and for their comments on the veracity of the assessment. Quite a bit of public scoping had already occurred prior to the analysis, as a result of the forest health concerns, and a focus group had already been formed. This early scoping helped the forest to focus on the Suttle area as a planning project. We sent out a letter introducing the project in August, 1992. On Sept. 25th, we sent an update and an invitation to a Suttle planning field trip held on Oct. 9th. The field trip was attended by 2 resort operators, 4 forest industry representatives, 3 members of Friends of the Metolius, one person from OSU, 2 people from Bend and a Z21 reporter. Also in October, we sent out a "forest health" newsletter called "Bug Bites". A copy of the full Suttle Report was sent to members of the forest health focus group and the Santiam National Scenic Byway focus group. Some members of the public are pleased that we took a more comprehensive and ecologically based planning approach. Others were very disappointed that we were still planning and not "doing." And some were confused about how the IRA related to real projects that actually did something.

II. Analysis Process

In order to integrate landscape ecology concepts, we needed to describe the landscape and its ecology. We used an approach that essentially asks:

1. What can the landscape produce?
2. Where can we get the things we want?
3. How much of these things do we get?

The process applies to both commodities and amenities. It emphasizes what we <u>leave</u> rather than what we <u>take</u>. The approach to the land becomes ecologically-based, resource-neutral, rather than the other way around. The process helps us view structures and ecological functions at the landscape level and brings the exisiting landscape pattern into the picture at the end, rather than at the beginning of the analysis.

To start, we separated the analysis area into patches that contained similar vegetation, productivity, and demands in terms of human use. The major patch types include: mixed conifer, meadow, lakes, burn, three conifers, ponderosa pine/incense cedar, riparian, ponderosa pine, cinders, and intensive human use.

Next, we described the major flow phenomena for the area. Flow phenomena are elements or organisms that move through the entire area, and into and out of the area. Landscape flows include <u>routes</u>, such as major roads, trails, streams, ridges; and <u>phenomena</u>, such as people, livestock, wildlife, fire, wind, water, disease and insects. A matrix helped us understand how the flow phenomena interact with patch types. We tried to focus functions, such as human use and ecology, and ways of functioning, such as capture, production, and cycling (Figure 8).

Describing links between this analysis and the rest of the district served to connect the analysis area to the larger landscape. Living and non-living things that cross these borders include US Highway 20, Link Creek/ Lake Creek watershed, northern spotted owls (and HCAs), and livestock.

Next we turned to the LRMP to find out if the management direction for the various allocations within the patch could conflict. Based on this examination, we placed all lands in the Metolius Conservation Area and the HCA into a separate patch types. In both these areas management direction will produce a different patch type than we initially thought.

We listed important elements we need to consider in applying management direction to each patch type at the project level. We included important landscape pieces we wanted to maintain, enhance, and protect, as well as how much fragmentation the LRMP or the public will accept. We needed to insure patches remain connected to provide travel corridors and migration routes.

Lastly, we needed to decide how much we will mimic nature in producing the various goods and services from this area.

After all this analysis, we developed a landscape unit map of Suttle Lake basin. Each landscape unit consists of areas or patch types where management activities will produce the same type of landscape or where a particular consideration drives all management activities.

In order to accomplish the tasks, the district had intended to hire a "forest health" team but, unable to do this, management pulled together a team of district employees, NTE specialists, and an ID team leader detailed from the Mt. Hood N.F. Resource assessments began at least a month before the team leader was selected, which made for some uncoordinated first efforts. Once the team leader arrived, the team came together in a formal information sharing meeting and began the landscape analysis and design process. At that point data gaps were identified and field efforts were better coordinated. Several field trips provided much needed team building.

A key assumption for planning was that the effort would be based primarily on existing data. More detailed inventories, etc. would be accomplished at the project design level.

The type of existing information that was used included stand exam data, soil (SRI) maps, water quality information, some fisheries information, cultural resource survey information, and traffic counts.

New information included: mortality plot surveys (E. Or. Mortality Plot Survey), Ecologically Significant Old Growth maps, noxious weed survey information, spotted owl habitat maps, wildlife habitat information (snags, downed wood, forage), yew locations, stream channel mapping and classification, scenery assessment, campground data analysis, cultural resource field inventory in areas of high probability, sensitive plant surveys, road densities, and analysis of detrimental soil conditions.

Standard field surveys were used to assess wildlife, sensitive plant, cultural resources, and fuel loading. Stream channels were mapped and classified. One perennial stream was surveyed using the Regional protocol. A permanent stream that was discovered during the IRA was sampled with electrofishing equipment. We assessed intermittent and permanent streams mapped during the IRA for channel stability and woody material, and conducted a Watershed Improvement Needs Survey.

Soil field sampling verified and identified the extent of soils in detrimental condition. Snags and downed logs were sampled in 143 one acre plots scattered through 73 forest stands.

We used a computer perspective model to identify the

	Flow Phenomena						
Patch Type	People	Livestock	Wildlife	Fire	Wind	Water	Pests & Disease
Mixed Conifer	Wood products, winter & summer recreation, scenery (US 20), hunting, firewood, Xmas trees, berries, mushrooms, Yew-taxol	N/A	Forage, dispersal, nesting: spotted owls, Cascade frog, woodpeckers; forage & cover: deer, bear; forage & nesting: buteos, golden eagles; possible users: elk, pine marten, bats	Nutrient cycling; volatize nitrogen, create snags and large woody debris, stand replacing event	Seed dispersal.	Capture, storage, transfer. thru surface and subsurface flow, nutrient cycling, seed dispersal.	Nutrient cycling, create snags and large woody debris, create canopy gaps, mistletoe created nesting habitat.
Meadow	Scenery, picnicking, trail use summer and winter, possible cultural significance	N/A	Forage for grazers, possible nesting for some birds, horizontal diversity	Nutrient cycling, volatize nitrogen	Seed dispersal	Capture and storage, nutrient cycling	None identified
Lakes	Water sports, drinking water (Dark Lake), fire suppression water source	N/A	Water, waterfowl, fish and beaver habitat, forage for water plant consumers, bald eagles, osprey	Fuel break	Shoreline shaping, nutrient cycling	Capture, storage, nutrient transfer and cycling	Mosquitos
Burn	Scenic variety	N/A	Forage for browsers, horizontal diversity	Nutrient cycling, volatize nitrogen, create snags and large woody debris, stand replacing event	May increase blowdown in adjacent stands	Capture, storage, transfer thru subsurface flow, nutrient cycling, seed dispersal	Nutrient cycling, create snags and large woody debris, create canopy gaps, possible cleansing of tree root diseases

Figure 8. Interaction matrix between flow and patch types (from Suttle IRA, 1992)

"seen" area from high use roads and recreation areas, and mapped recreation sites and trails.

Several ecosystem processes were of high profile due to the publics concern about fir defoliation, agency concern for eagles and owls, and concern over the high risk of catastrophic fire. Thus, the focus of the analysis was on the role of insects and disease and fire in the ecosystem. The landscape analysis and design process requires an examination of the larger context within which the planning area is situated. Landscape "flows", things that move across the landscape, were identified. These included people, water, and many important wildlife species. Functional and programmatic links were identified. For example, the National Scenic Byway traverses the planning areas and links it to the surrounding areas. Link and Lake Creeks connect the area to the Metolius River and on to the Deschutes River. Recognition of these aspects of the ecosystem ultimately contributed to the development of landscape objectives.

We considered time scales in an assessment of fire ecology, describing pre-suppression fire frequency, the history of timber harvest activity, and human use of the area .

Conditions on adjacent lands were considered but no intensive sampling was done, or data used. The discussion of landscape links and flows identified some of the significance of some conditions on adjacent lands. The planning area included the Corbett State Park and a section of private land (Willamette Industries). Field observations were made in these areas, but no quantitative information was available. Subsequently the Forest acquired the section of private land. Although comments were invited from State Parks, very little involvement occurred. Planning recommendations were made for the Park lands.

Terrestrial and aquatic concerns were interwoven throughout the analysis and design. The geomorphology of the landscape naturally focused attention on the aquatic resources. The obviously defoliated condition of the forest focused attention on the terrestrial environment. Management recommendations focus strongly on restoration and maintenance of conditions within both environments.

III. Products and Results

The products of the analysis include delineation of "landscape units" tied to condition statements and project recommendations. Products also included a number of specialist reports, a summary report that includes management recommendations and prioritizes projects. The report includes a detailed description of the desired future conditions by landscape unit and describes some of the tradeoffs confronting managers.

A reserve system was not specifically identified. However, the "lakes" and "riparian" landscape units could function as an aquatic reserve system. Management recommendations have been developed for these areas.

The analysis was synthesized by following the landscape analysis and design process. This process relies strongly on the interaction of planning team members to generate both an integrated vision of the future for the area and an integrated management strategy. No sophisticated GIS or other computer models were used for this synthesis.

The analysis identified what projects could help to create the desired ecological conditions for the area. Projects have been listed and prioritized. In addition to providing a comprehensive and more ecologically based management strategy for the area, the planning effort also created a strong data base to use for project analysis. Work has already begun on several projects including lakeside bank restoration, campground vegetation management, and Lake Creek foot-bridge reconstruction.

IV. Logistics

The disciplines involved in this planning effort included: landscape architect, silviculturist, recreation planner, fuels planner, wildlife biologist, hydrologist, fire ecologist, botanist, soil scientist, archeologist, transportation planner and special uses.

The cost for the effort has been estimated at $108,000.00, which accounts for approximately 9000 hours of work. This does not include any overhead.

V. Opinions About the Process

What Would We Keep the Same:

We had a team leader (Lousia Evers, Barlow District, Mt. Hood N.F.) who was able to work on the IRA full-time. She was able to focus on the project, and give it the attention it needed to be successful. As a fire ecologist, she contributed greatly to the analysis. She was able to devote the necessary attention to team facilitation, another aspect that is critical to successful teamwork and project synergy.

The Diaz / Apostol process was well liked. The basic framework provided the necessary steps to push the analysis and design as far as the group desired. In future use, I would "push" the analysis more to look at and model ecology of the area (ie: bubble diagrams showing function, process, structure). The addition of an ecologist to the team would help this effort.

Use "landscape units" to identify reserve boundaries. The landscape unit concept can locate reserves that are more integrated and make better geographic and management sense.

The team benefitted from the two public focus groups that had been previously established (the Forest Health Focus Group and the Mckenzie/Santiam National Scenic Byway focus group), and avoided the "shot gun" approach to the public involvement.

The "team teaching" that we did was very important, especially the initial "formal" sharing of specialist information. This step is essential for the team members to be able to work from a common understanding of the landscape.

The team makeup was a combination of district employees with intimate knowledge of the planning area and detailers who brought a fresh perspective to the group. This combination of insiders and newcomers created a team synergy which encouraged both depth and breadth of planning.

Emphasize team interaction. Do not underestimate the power or synergy of team interaction. Team composition and facilitation is very important.

What Would We Do Differently:
The planning area boundary should have been more ecologically based, rather than influenced by land lines and temporary legal status.

Don't be afraid to expand the planning area to allow for a more ecologically meaningful assessment. On the other hand, be very clear on what depth of analysis will be necessary. Avoid excessive and costly detail that does not contribute to meeting the planning objectives.

When identifying the "target" landscape or "desired future condition" don't focus on one condition; talk instead, in terms of target conditions or range of acceptable conditions, which is more reflective of the innate variability and oscillation found in nature.

Get the team leader on board before the team starts work. Our team could have been more efficient and effective with better direction, sooner.

Use the public more directly in the planning process. Involve some interested citizens in the field work, the team work, the designing process, etc. This may lengthen the process, but could have other benefits.

We could have benefited from an operating GIS system. This would have improved our graphics and data comprehension.

We should have taken the time to produce a report that is more user friendly and available.

Advice:
Be as clear as possible from the start about what the planning process will be, what the planning objectives are and what "depth" of data will be collected. At the same time allow for constant adaptation and incorporation of new ideas, concepts and techniques that could improve the planning. Allow the process to be iterative - as it should be.

Do not be distracted by the pursuit of science. Keep in mind that the goal is to "plan"...not to find the meaning of life. There should be an ongoing discussion concerning how good is good enough. This is healthy and avoids wasting resources with purely academic pursuit.

Use GIS to identify and assess gross changes and effects that may result from various management strategies. For instance, trade off analysis can be helped with the use of GIS, (assuming you actually have the freedom to manage the landscape).

The results of a forest-wide or province-wide gap analysis (habitat-based biological diversity assessment) would have been very useful to our efforts. We could have "nested" our analysis within this larger biological context. Our efforts to plan for wildlife and plants could be more effective if they had used this sort of larger scale information.

Suttle Basin
evaluation

kudos

• integrated social values (aesthetics) with ecological components
• recognized the context of components in the system by illustrating flows of inputs
• included public involvement from the beginning
• the Diaz/Apostle model forced the team to integrate all specialties into the analysis
• this process leveled the playing field among disciplines; it developed a strong "team approach" which led to considerable sharing of information among the team members
• added new language (structure, flow, etc.) to lexicon of WA
• provided context for programmatic links
• integrated a wide variety of patch types in to a range of desired future conditions
• included wildlife values
• recognized and encouraged the dynamics of a working team by allowing objectives to change during analysis

critiques

• the analytical boundaries of this analysis were administratively drawn and therefore may exclude ecologically significant elements or processes
• need to recognize the opportunities for shared learning among agencies and public
• need to set this analysis within the larger context of the landscape
• it is unclear at what point the objectives were set; need a statement at the beginning to direct the logic
• need clear team leadership from the beginning
• need mechanism to alter team membership, if necessary
• need a broader analysis to address conflicting management objectives
• need more analysis of fish and aquatics

considerations

• need to design a "media module" to keep public informed through regular media updates
• need to clarify cause and effect within the analysis

Suttle Basin analysis summary

The Suttle presentation featured organizational and conceptual models which may be used in future Watershed Analyses: the Forest Service R6 Integrated Resource Analysis (IRA) process (Pacific Northwest Region 1990) and the Forest Landscape Analysis and Design approach (Diaz and Apostol 1992).

An IRA is an integrated analysis across all resources to assess current conditions within an area (usually <50,000 acres). It evaluates cumulative effects, and identifies, prioritizes, and coordinates projects to achieve the desired future conditions established by the Forest Plan for various management allocations within the area. It is not a formal planning level under NEPA but is intended to allow implementation of the Forest Plan, to improve spatial disaggregation, scheduling, budgeting, and feedback for potential amendments to the Forest Plan based on site specific conditions. The analysis can be used to support project-level NEPA planning and documentation.

Forest Landscape Analysis and Design (FLAD) applies landscape ecology principles to recommend landscape patterns that synthesize ecological function with management objectives and contraints within the Forest Plan. The method uses two phases. The Analysis phase identifies landscape elements (patches, corridors, matrix) and patterns, landscape flows, relationships between landscape elements and flows, natural disturbance and succession processes, and linkages to adjacent areas. The Design phase melds Forest Plan objectives with ecological objectives identified in the analysis phase to describe a "target" landscape pattern for various parts of the planning area, and it creates narratives and maps to guide project planning.

The Sisters Ranger District chose Suttle Basin as the site of its first IRA in part to address concerns about "forest health" problems visible to highway travellers as well as to the year-round flood of visitors. The Suttle IDT found the FLAD framework suitable for the analysis because the problems seemed to result from large scale ecological conditions. Linking the fire regime, succession and stand conditions, fire exclusion, and insect/disease outbreaks allowed the team to outline stand conditions and landscape pattern which may address management and public concerns about stand mortality and fire risk in a high recreation environment.

The Diaz and Apostol approach produces an analysis which appears appealing and simple. The charts, diagrams, and maps combine as an excellent communication device and can be particularly useful in public participation. They also integrate specialists' inputs for the landscape units. The danger in applying FLAD is that it may stay at a very conceptual stage. While it is integrated, the breadth of the project may not be matched by the depth of a rigorous, quantitative analysis.

Clearly, the Suttle example does not provide well developed riparian/aquatic elements. It lacks risk or sensitivity ratings which could allow reserve boundary delineation or cumulative effects analysis. The challenge in adapting the Suttle IRA approach for WA will be to integrate riparian/aquatic strata into the landscape unit-based analysis, with process links between upland and riparian elements.

Suttle did not cover an ecological unit, but a relatively small administrative one. IRAs can be designed on arbitrary units which do not nest into ecologically meaningful hierachies, making it difficult to aggregate and disaggregate information from different scales. It appears likely that IRAs and Watershed Analyses need not be mutually exclusive and need not be at the same scales. IRAs are intended to implement a Forest Plan in an ecologically responsible manner, while Watershed Analyses are not explicitly confined by existing ownerships, allocations and objectives. It may be that the two are complementary, with IRAs able to draw on Watershed Analyses for their biophysical and social context.

The Suttle IRA example shows that existing planning processes (IRAs) can serve an iterative role in the evolution of WA. Watershed analysis teams may find the landscape design conceptual framework useful in identifying important processes and patch types, as well as seeing how these are related in the watershed. However, a rigorous riparian/aquatic analysis must be included.

Diaz, Nancy and Dean Apostol, 1992, Forest Landscape Analysis and Design, USDA Forest Service Pacific Northwest Region R6 ECO-TP-043-92)

Pacific Northwest Region, USDA Forest Service, 1990, Steps of the Journey: Forest Plan Implementation Strategy

Watershed/Landscape Analysis Workshop
Augusta Creek Analysis

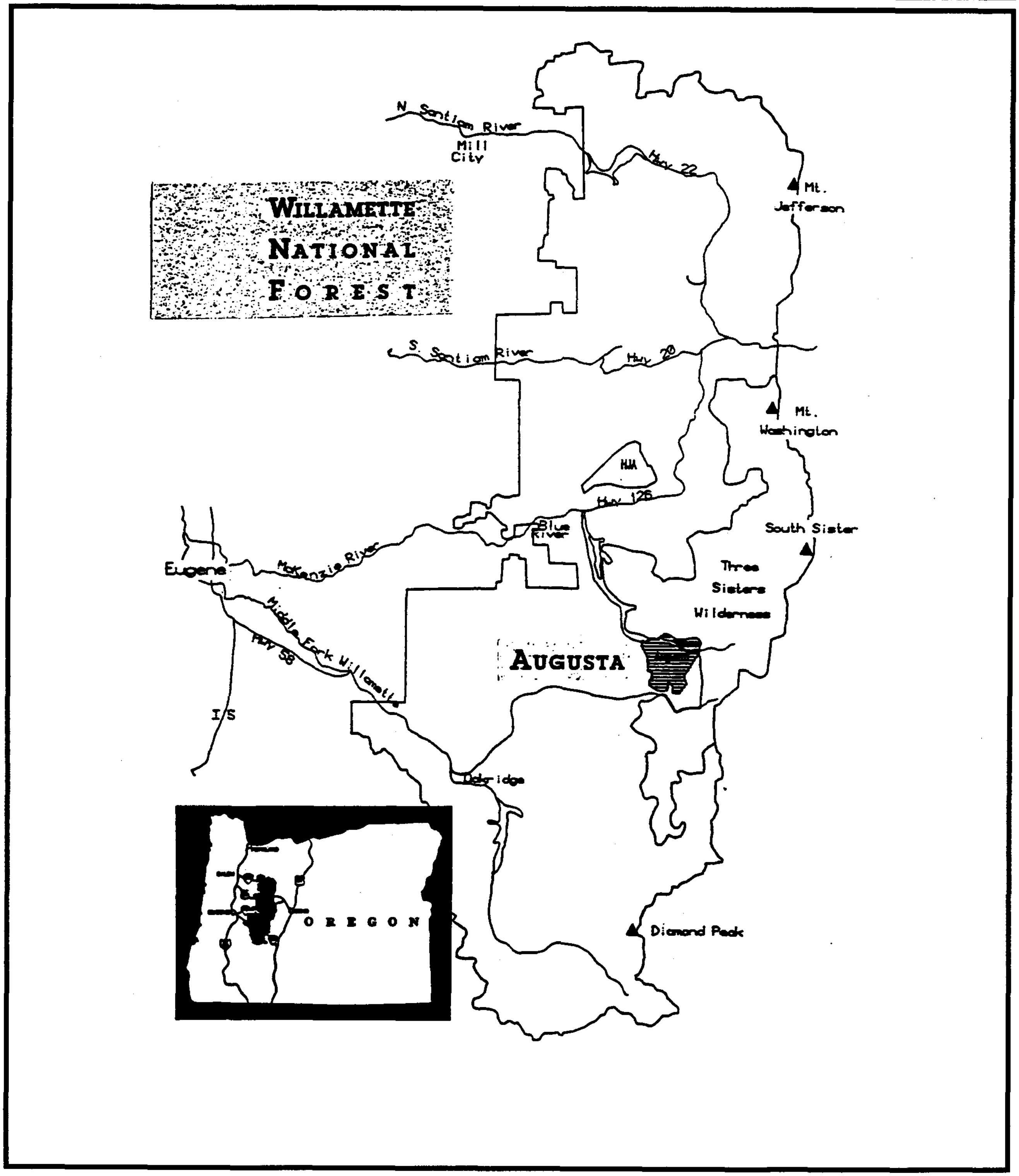


figure 9

Augusta Creek Analysis

condensed and suplemented from:
Integrating Landscapes, Watersheds, and People for Ecosystem Management: The Augusta Creek Project
(Cissel, Swanson, Grant, Garman, Wallin, McSwain et al.)

I. Objectives

The Augusta Creek project was initiated to establish objectives for ecosystem management based on historic landscape patterns. Developed through the Cascade Center for Ecosystem Management, the project linked the efforts of both researchers and managers to describe desired landscape patterns and to demonstrate a planning process that would contribute toward realizing those desired patterns. The continuing goal of this project is to create an exchange of information to adapt management and build knowledge toward beneficial landscape patterns.

The specific goals of the project are to:

1. Develop objectives for a desired landscape pattern that:
   - reflect the range and variability of historic landscape patterns
   - integrate riparian and stream channel objectives
   - incorporate human use patterns
2. Demonstrate a planning process to attain and sustain the desired landscape pattern
3. Use the desired landscape pattern to help set stand-level objectives
4. Evaluate the consequences of the desired landscape pattern

Area Description

The Augusta Creek project area encompasses 19,000 acres in the South Fork of the McKenzie River watershed in the central western Cascades of Oregon (Figure 9). The steep, dissected mountains of the project area are fairly typical of much National Forest land in the western Cascades. Elevations range from 2300' to 5700'. Most precipitation falls as rain at the lowest elevations, while a seasonal snowpack usually develops above 3500'. Douglas-fir is the dominant tree species over most of the planning area, with western hemlock and western redcedar being the most common associates. Grand fir intermingles on drier sites, while Pacific silver fir and noble fir dominate colder sites. Mountain hemlock is common above 5000'. Old forests and complex stand structures prevail over large portions of the planning area, although plantations (regenerated following clearcuts) are dispersed throughout most of the roaded area.

Landscape Plan Objectives and Assumptions

We used the following management objectives:

1. Maintain a mix of plant and animal habitats to sustain populations and ecosystem function;
2. Minimize management-induced risks to soil, water, and riparian resources;
3. Meet human needs for a broad spectrum of recreation settings, natural forest scenery, hunting and fishing opportunities, timber, and a variety of other uses.

We developed a projected landscape pattern to meet these objectives based on two broad assumptions. The first assumption is that landscape patterns that fall within the range of historic landscape conditions may have a better chance of maintaining species and ecosystem function than those that deviate substantially from historic patterns. Given our current sketchy understanding of habitat requirements and ecosystem processes, reliance on the pattern and structure of historic landscapes as key reference points may be the most practical approach to ecosystem management in many cases.

Our second broad assumption is that explicit objectives for landscape pattern should directly link to project-level management activities. In other words, the focus of management in this approach is to attain and sustain a range of conditions, and products taken from the system are an important but secondary objective.

This project has been conducted as a case study and not as a decision process. The public has been involved in various informal ways in this project, but not in any formal manner. We have presented this information on dozens of tours and to dozens of workshops over the last two years and received valuable and voluminous feedback. Additionally, we held an informal, one-day workshop last spring with a group of 15 diverse members of the public to share information and to get advice on how to proceed with analysis and public involvement. We've acted on the social analysis advice, but have not been able to implement other recommendations.

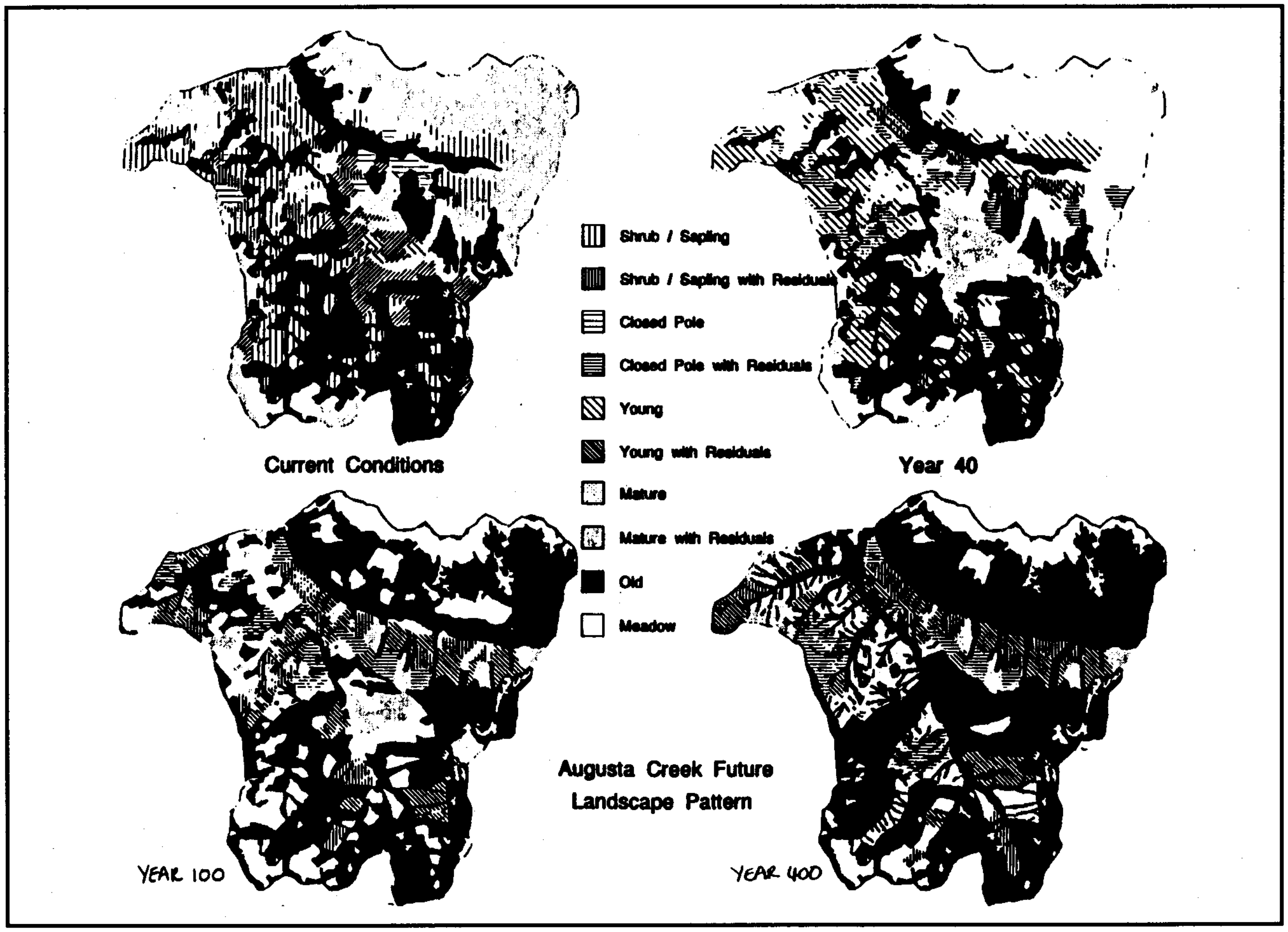
II. Analysis Process

It was first necessary to analyze the historic and current conditions of three landscape characteristics: vegetation patterns, hillslope to stream channel disturbance processes and patterns, and human use patterns.

1. Landscape Vegetation Pattern

We characterized historic landscape vegetation patterns by looking at the primary pattern-generating process: fire. A field study used dendrochronologic techniques to collect plot-level data from stumps and increment borings (Connelly and Kertis 1991). Tree and fire scar ages from

Figure 10. Augusta Creek Future Landscape Pattern



about 300 plots were used to date and map twenty-three stand-replacing or partial stand-replacing events. These fire-event data were condensed into general descriptions of nine fire regimes and resulting landscape patterns (Figure 10). In spite of much variability, specific patterns appear to correlate with certain parts of the planning area. Landforms and topography appear to control the wild fire regime to a significant extent and, therefore, provide a basis for mapping fire regime from patterns of fire events.

Current stand conditions were also mapped as a set of stand structure classes. Although the area has been severely fragmented by forest cutting over the last 40 years, several large blocks of mature and old forest remain. In other places, large blocks of young forest have been created through forest cutting. Large blocks are important landscape elements because they provide critical habitat for some species (FEMAT 1993), and are difficult to restore, once fragmented. We mapped the existing large blocks of vegetation as key elements of current and future landscape patterns.

2. Riparian and Stream Patterns

In order to incorporate riparian and stream channel objectives within the broader upslope landscape pattern, we described and mapped the processes that link the upslope to the stream channel. First, we mapped landslide potential in high, medium, and low classes as a function of soil depth, bedrock type, and slope steepness, as interpreted from the Willamette National Forest Soil Resource Inventory. Predicted hazard ratings were found to be in general agreement when compared to an inventory from aerial photographs of actual landslides. Most observed landslides fell within the "High" category, and comparatively few occurred within "Medium" or "Low" categories.

To determine the susceptibility of different stream reaches to debris flows, a stream network map was overlaid on the slide potential map to yield a map of debris flow potential. The predicted hazard ratings were compared to the historical record of actual debris-flows, as inventoried from an aerial photograph time series. Agreement was generally good, although some debris flows have occurred on stream segments rated as moderate or low hazard, and most of the stream network rated as "high" hazard have not experienced any observed debris flows in the last 50 years.

To characterize sources and patterns of disturbance events over time, and to evaluate riparian forest conditions, we analyzed historical photos from 1959 (prior to cutting and '64 flood), 1967 (post-'64 flood), 1979, and 1990. Results from these analyses show that: a) there were extensive areas of open canopy conditions along the main stem of Augusta Creek and major tributaries prior to cutting, b) there were persistent, intermittent debris flows and slides present in 1959, c) road building and timber cutting increased the frequency of landslides and debris-flows, d) higher order streams have a higher level of closed canopy forest today than they did in 1959, and e) lower order streams have a lower level of closed canopy forest today than they did in 1959.

Peak flows due to rapid snowmelt during rain-on-snow events are the primary cause of channel and landscape altering floods in this area. Peak flows were analyzed by modeling the sensitivity of different parts of the watershed to snow accumulation and melt. Snow accumulation and melt maps were combined with a map of groundwater storage (as interpreted from the Soil Resource Inventory), to produce a map of potential contribution of different parts of the landscape to produce peak flows during rain-on-snow events.

The baseflow analysis also used the potential snow accumulation and groundwater storage maps. Baseflow was assumed to be related to locations of late melting snowpacks that were modeled as varying by elevation and aspect. Areas lower in the watershed and with southwest to southeast facing aspects were assumed to lose their seasonal snowpacks first, followed by mid and higher elevation zones and more north-facing slopes. Snow accumulation, seasonal snowpack melt rate, and groundwater storage were combined to map the estimated contribution to summer base flow from different parts of the landscape.

3. Human Use Patterns

Human use most likely began about 13,000 years ago when the Paleoindian populations expanded into higher elevations as glaciers receded (McAlister 1991). Evidence indicates that over time there was increased differentiation of social groups, population growth, and expanded long-distance exchange networks. An 1851 map shows the Augusta area to be within the territory of the Santiam band of the Molala Tribe (Gibbs and Starling 1851). Based on the very limited Molala ethnographies, the area was utilized from late spring to fall for hunting and gathering by mobile, family-based groups who wintered in the lower elevation river valleys. Roots, berries, deer, elk, bear, salmon, trout, and eels are mentioned as resources exploited during the warmer months (Rigsby cited in Beckman et al 1981:92).

Later in the 19th century, Euroamerican settlers replaced native inhabitants and removed survivors to reservations. Seasonal subsistence forays by groups from the Warm Springs Indian Reservation continued throughout the upper McKenzie country, while settlers from the McKenzie River valley began using areas such as Augusta Creek for hunting, fishing, and huckleberry picking. The upper ridges in the Augusta area support several productive huckleberry patches as well as meadows which were grazed extensively by sheep around the turn of the century as part of the McKenzie River range allotment within the Three Sisters District (McAlister 1991). Anecdotal evidence indicates that fire was used by both Native Americans and sheepherders (Coville 1898).

The beginning of the 20th century ushered in an era of vigorous fire suppression, leading to construction of fire lookouts, access trails, and telephone lines within the Augusta area. Human use of the area expanded considerably after World War II. Large-scale forest cutting began in the 1950s, roads were built, and recreational use of the area rose concurrently. Today, there are trail systems along Rebel Ridge (in the Three Sisters Wilderness) and Chucksney Mountain, and campsites are spread along the South Fork of the McKenzie River, which is currently being considered for Wild and Scenic River status.

III. Products and Results

1. Desired Landscape Conditions and Management Approaches

We translated information derived from the previously described analyses into specific criteria to meet landscape pattern objectives. We solicited input from forest ecologists, ranger district managers and specialists, ecosystem and social scientists, members of the public, and a wide variety of others through many field trips, meetings, review sessions, and presentations of the work in progress. In the end though, our personal judgments were required to integrate this information into one set of desired landscape conditions. Our logic led us through these steps:

1. Identify large "natural succession" areas, or reserves. We based the reserves on hazard avoidance and human-use patterns, as expressed through the decision-making history (i.e., the Forest Plan);
2. Translate a general interpretation of the historic landscape pattern, and how it differs across the landscape, into a first-cut statement of desired landscape pattern. Timber cutting was assumed to be the primary pattern generator;
3. Modify this pattern based on current conditions and the potential implications to hydrologic and hillslope disturbance processes and fish habitat;
4. Define a riparian network management strategy and the linkages with the broad landscape pattern;

5. Fine tune to incorporate other issues, such as big game hunting and scenic areas.

An understanding of historic disturbance patterns as they affected both forest vegetation pattern (though fire) and stream channels (through floods, landslides, and debris-flows) was fundamental to this planning process. In the case of the forest vegetation pattern, we assumed that the goal of management outside of reserves was to replace fire with timber-cutting as the major pattern-generator. (Prescribed fire may be a practical option in some parts of the reserves, especially meadows.) This leads to a proactive management role. In the case of channel disturbance from hillslope to stream, we assumed the goal of management was to minimize increase of disturbance. This leads to a hazard-avoidance or protective management approach. In either case, a historically-rooted understanding of disturbance patterns is an essential prerequisite to setting desired landscape conditions that are both linked to ecosystem performance and specific enough to be useful.

We developed an outline of intended management approaches (e.g., timber cutting frequency and intensity) concurrent with the desired landscape conditions. This improved both our ability to communicate and to test the practicality of our concepts, using generally understood management concepts, such as rotation age and canopy retention levels, to facilitate operational review.

We subdivided the Augusta Creek project area into eight subunits (termed landscape areas), ranging in size from 1,000-5,000 acres. Each landscape area has a unique set of desired landscape conditions and management approaches based on the specific historic use and landscape patterns, hillslope to stream channel disturbance processes, and current conditions.

2. Landscape blocks

Three of the landscape areas have desired conditions specified for landscape blocks. Desired conditions for these three landscape areas call for a certain proportion of the landscape area to be in blocks of a size that exceed the typical size of cutting units on Federal lands. Landscape blocks have the same general stand structure within a given block. They locate management activities in space and time to create vegetative patches of desired size, structure, and composition. They also provide a means to schedule management activities so that desired distributions and proportions of different stand structures can be attained and sustained over the landscape. Landscape blocks provide a practical means to tie broad landscape pattern objectives to conditions over time on a specific piece of ground. Managers can then compare existing stand conditions with the projected set of conditions for the corresponding landscape block to determine the type and timing of management activities.

3. Long-term Landscape Pattern

In a system where forests are not judged to be old until they are 200 years of age (Bulletin #447), long-term views are essential. We projected landscape pattern for 400 years to demonstrate an approach to sustaining a desired pattern, to determine the rates and locations of management actions needed to achieve the desired pattern, and to allow evaluation of the long-term implications of this pattern.

We adapted forest planning procedures for long-term analysis of forest growth and development, and to schedule management actions. Landscape blocks were the basic land units in the analysis. We developed a simple structural-stage progression keyed to time since regeneration cutting. We then scheduled landscape blocks for cutting to meet the desired proportions of each structural stage following these criteria:

1. Disperse landscape block cuttings so that adjacent blocks are not cut in consecutive time periods;
2. Delay cutting in blocks where stream surveys show channel and riparian conditions are in need of recovery;
3. Schedule initial cuttings in blocks that are currently the most fragmented;
4. Delay block cutting adjacent to existing large openings;
5. Schedule cuttings so that the mix of block sizes cut in any time period is representative of the total mix within the landscape area.

Several iterations were necessary to attain a feasible pattern.

Transformation of the current landscape towards desired landscape conditions occurs at different rates within different landscape areas, depending upon the degree of past fragmentation and the future rate of cutting. Nevertheless, the desired pattern is largely in place within 100 years, and firmly established by year 200. The projected pattern remains stable beyond year 200 as stands grow and landscape blocks are reset to early seral conditions through cutting to achieve desired landscape conditions.

4. Implementation

Projecting a desired landscape pattern over the long-term provides managers with a context in which to set stand-level management objectives. The type and timing of silvicultural activities can be established by comparing current and projected stand conditions with the desired landscape pattern over time. For example, specific decisions on stocking levels and timing of thinnings can be tiered to the timing of the overall landscape block schedule.

Projecting a long-term landscape pattern also allows managers to focus potential regeneration cutting. Planners can identify the landscape blocks scheduled to be in an early seral condition in the near-term and plan stand-level timber cutting on those blocks. Timber cutting could be focused on those blocks with some confidence that many landscape objectives have been considered, and that silvicultural activities in those blocks contribute to larger landscape objectives.

Establishing desired landscape conditions based on the range and variability of historic conditions can establish fairly specific starting points for silvicultural planning within a landscape block. Variation across landscape areas reflects the variation in historic patterns. Options requiring evaluation at the landscape block scale include the specific patterns of canopy retention within the block, potential use of fire, the timing of activities to achieve a similar stand structure over the whole block, logging systems that will meet the desired condition for the block, etc. Developing prescriptions at the landscape block scale to meet desired landscape conditions is different from prescriptions developed at the traditional cutting unit scale, and offers creative opportunities for ecosystem management. Landscape blocks aggregated to a watershed-scale analysis offer opportunities for watershed recovery and restoration projects.

The Augusta Creek project area is within a larger watershed slated for a pilot watershed analysis. Several of the restoration projects identifed through ground surveys will be going through project level planning in 1994 or 1995. A prescribed fire project is also ready for project planning. An interpretative kiosk is in the planning phase. However, timber cutting projects have not yet been initiated in this area due to Judge Dwyer's injunction and uncertainty over FEMAT implementation.

IV. Logistics

We have spent more time discussing our methods than actually doing the work. Significant energy went into developing products for tours and talks, and into analyses to meet research objectives. A short list of time and skills includes:

Fire History Study - field crew of 2 for four months, skilled crew leader and initial analysis for 7 months, ecologist for 2 months.
Stream Analysis - hydrologist for 3 months
Fish Biologist, Archaelogist, Fire Specialist, Silviculturist for 1 month each
Planner - 5 months
Stream Survey - field crew of 2 for 2 months
Fish Survey - field crew of 3 for 1 month
GIS Workstation and Operator - 12 months
Wildlife Biologist - 2 months, plus time to build a bird-modeling tool.
Research input - 2 months total from a variety of individuals, most of which has been in the form of concepts and ideas, and some particular analyses.

V. Conclusions

1. The team needs to periodically ask itself if the products are at the right level of resolution for the scale of the analysis.
2. The team needs to work in parallel, bringing comparable information together for the creative and synthetic steps.
3. Higher levels of integration increase the odds of success.
4. Historical context is very valuable to help undertand the dynamics of the system, the variability of the area, and to tune objectives and prescriptions to the site.
5. The team needs to periodically ask itself how objectives and products from the analysis are going to link to objectives and products at higher and lower scales.

Augusta Creek
evaluation

kudos
- set within the context of a broad temporal scale
- good integration of temporal and spatial components
- rich with ground-based data at a useful resolution
- included archaeology layer
- photo simulations were used as effective communication tool
- demonstrated how riparian buffers would merge into the landscape over time
- addressed non-forested components (meadows)
- analysis provided direction to projects on the ground
- strong partnership with research

critiques
- need fish and wildlife layers (including habitat, distribution, trends)
- need to fit analysis into larger regional and social contexts
- need to articulate the values implied in the analysis; how do you decide what is good or desired?
- need to get the public involved at the beginning

considerations
- need to consider catastrophic changes to landscape condition
- need a cheaper way to collect fire history when an intensive dendrochronology study is not possible

Augusta Creek analysis summary

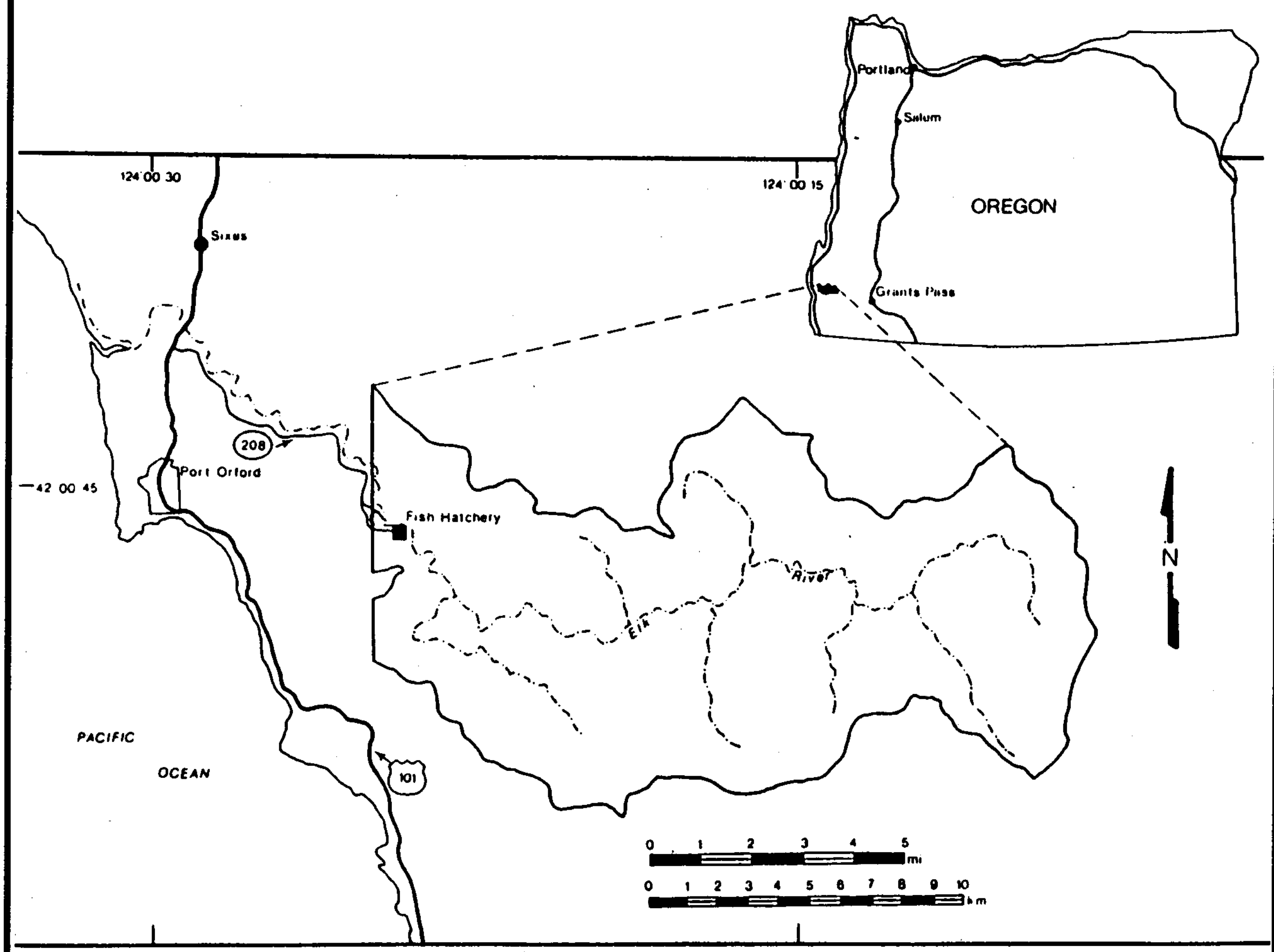
Analysis of the Augusta Creek watershed grew out of the desire of resource specialists and researchers with the Cascade Center for Ecosystem Management to develop an example of ecosystem management at a landscape scale. Drawing upon the rich data resources from the nearby H.J. Andrews Experimental Forest, Augusta Creek was viewed as an opportunity to learn how to set objectives for landscape patterns and activities on exclusively Federal lands in the western Cascades. The Augusta Creek analysis used an understanding of historic disturbance regimes as a basis for setting management direction toward desired conditions for Federal lands. Drawing on an analysis of fire history and vegetation patterns, landscape units were defined based on the interpreted size, frequency, and severity of historical fires. These landscape units were then further delineated into landscape blocks to be managed along corresponding gradients of patch size, rotation length, and level of green tree retention.

A complementary analysis of channel and riparian networks evaluated susceptibility of different parts of the landscape to a range of hydrologic and geomorphic processes, including peak flows, contributions to summer low flow, landslides, debris flows, and riparian canopy opening. Aerial photo analysis of historical patterns of landslides, debris flows, and channel openings served as the basis for determining susceptibilities, which were used to draft revised riparian reserves.

The strengths of the Augusta approach lies in the strong terrestrial component, use of historic disturbance regimes as a reference point for defining management activities, and the actual casting of the results of the analysis in terms of design of harvest units to meet objectives of restoring a more natural landscape pattern. Retrospective analyses of historical disturbances were integrated into prospective analyses of alternative future scenarios for the watershed over the next 200 years. The riparian/channel network issues were not as well developed, particularly with respect to identifying fish and aquatic wildlife issues and critical channel reaches from geomorphic and aquatic habitat perspectives. The terrestrial and aquatic components of the analysis need to be better integrated. While historical human use patterns were analyzed, there was limited attention paid to other social issues. Public participation was mostly limited to educational presentations in nearby communities and forums.

In sum, Augusta represents one of the best examples of terrestrial analysis, and carrying watershed analysis through to the level of designing management options which incorporate historical perspectives.

Watershed/Landscape Analysis Workshop
Elk River Analysis



Elk River Analysis

Chris Park, Cindy Ricks, and Glenn Chen
Siskiyou National Forest

I. Objectives

Elk River was designated as a Federal Wild and Scenic River by the Wild and Scenic River Act of 1988. Under this plan the Forest Service is required to provide a comprehensive management plan to provide protection for the values associated with the Elk River. The analysis focused on the outstandingly remarkable values of water quality and fisheries, and led to recommendations for new land allocations and standards and guidelines for Elk River to amend the Siskiyou National Forest Plan. Because of the mandated focus on aquatic resources, the terrestrial habitat and social values received less emphasis.

Pubic involvement was solicited at various times throughout the analysis. The public role was generally to respond to information and analysis by the Forest Service. The team also consulted with a scientific advisory committee consisting of three leading researchers in the fields of hydrology, geomorphology and fisheries.

Area Description
The Elk River watershed is located in Curry County in southwestern Oregon, part of a group of south coastal watersheds. The Elk River drainage encompasses 59,520 acres, with 46,965 acres within the Siskiyou National Forest boundary. The mainstem of Elk River enters the Pacific Ocean about five miles north of the town of Port Orford and approximately 50 miles north of the California border.

The marine climate is wet and mild, with an average annual precipitation of 90 inches near Anvil Creek to 130 inches in the headwaters. Approximately 80 percent of the precipitation occurs from October to March, and four percent during June, July and August. A transient snow zone occurs roughly between 2400 and 4600 feet, but this comprises a small portion of the watershed.

The Elk River watershed is located at the northern margin of the Klamath/Siskiyou Province and includes Oregon Coast Range Province (Cretaceous rocks). The watershed is elongated in the east-west direction, with the mainstem of the river fed by numerous tributaries (including six subwatersheds). The lower river flows through a broad valley, and enters the ocean through a relatively small estuary. Most of the basinis in rugged, steep terrain with inner gorges adjacent to streams. The steepest slopes on the Siskiyou National Forest are located in the Elk/Sixes planning basin.

Fisheries were identified as an outstandingly remarkable value for the Wild and Scenic River based on the presence of wild fish stocks, diversity of fish species, and high quality habitat. Elk River is recognized for its role in maintaining the viability of native salmonid stocks within this region. The basin produces anadromous populations of steelhead trout, coho and chinook salmon, and cuttroat trout. Resident rainbow and cuttroat trout populations are also present.

II. Analysis Process and Results

The analysis addressed two spatial scales, **watershed** and **subwatershed**. The watershed scale provided an understanding of the processes and conditions, values and uses within the watershed. The subwatershed scale (from 3000 acres to 8000 acres) increased the focus so that that current situation and probable cause could be isolated. Although broad-scale landscape analysis was not performed, the importance of Elk River to the Pacific Northwest fisheries was discussed.

The analysis was structured so that the processes can be followed from hillslope disturbance to effects on stream channels and fish habitat. Analyzed processes include:

- Landslide and Surface Erosion
- Large Wood Supply
- Riparian Canopy Disturbance and Stream Water Temperature
- Stream Flow and Response to Disturbance
- Channel Morphology and Response to Distur bance
- Fish Habitat, Distribution and Populations

Watershed Scale
Landslides and Surface Erosion:
Landslides and other slope features were identified and measured from seven sets of historical aerial photographs covering 1943 through 1979. These data were updated for 1979 through 1986 to include debris slides, debris avalanches, failing toes of slumps and earthflows, and debris flows using the same inventory methods. Information collected on the 223 slides within Elk River included area, slope, aspect, elevation, rock type, percentage delivery to streams, and photo-bracketed date of failure. The relation of the slides to harvest units or road construction was noted, and the date of such disturbance was recorded. Area, depth and percent delivery to stream channels were measured in the field for 25 percent of the landslides. A relation between photo-interpreted area and

field-measured volume was used to estimate volumes for slides that were not field-verified.

Road and timber harvest-related landslides and surface erosion differ from the corresponding natural processes in timing, amount of sediment delivered to a stream channel, amount of large wood included, and degree of disruption of the surface and subsurface flow of water. Along roads, soil disturbance and interception of water flow can cause landslides or erosion which would not occur under natural conditions. Comparing road and harvest-related landslides with naturally-occurring landslides shows that 2.2 times the natural volume has been delivered from roads and harvest over the inventory period.

Measurements show that road drainage erosion is a relatively minor component of sediment delivery due to the high rock fragment content of most soils. Gully erosion is more important where fine-textured soils are located.

Large Wood Supply

Large wood is delivered to a stream by either blow down or an upslope process such as landslides. A high watershed sensitivity map was constructed by interpreting aerial photographs to determine areas with the highest probability of failing and delivering sediment and large wood to a stream. High watershed sensitivity was mapped as a function of landform, slope, aspect, rock type, slope shape and proximity to a stream. The high watershed sensitivity map and GIS managed stands map (harvested areas) were overlaid and the percent loss of potential large wood estimated.

Large wood is delivered to stream channels by upslope landslides, from adjacent riparian areas, and by transport from upstream sites. Areas delineated as high watershed sensitivity for delivery of sediment are sources of large wood. Past harvest within these areas has reduced the potential supply of large wood to stream channels. Overall the watershed has had a reduction in potential large wood supply of 27 percent. While there is probably a sufficient supply of potential large wood within the watershed, specific areas maybe seriously depleted.

Riparian Canopy Disturbance and Effects on Stream Water Temperature

Continuous recording thermographs were placed at the mouths of major tributaries and several locations on the mainstem from the upper reaches to the forest boundary. This information was used to give a rough picture of the existing stream temperature regime. Changes in riparian shading were identified the sets of historical aerial photographs to determine how historical stream temperatures might have changed. In addition anecdotal evidence was collected from long-time residents.

The mainstem, as it appeared in 1940, was characterized by well-vegetated riparian areas consisting of primarily mature and old growth Douglas-fir mixed with hardwoods. Flood plains were vegetated with mature trees indicating major disturbances had not occurred in several decades.

Comparing the channel and riparian vegetation as it appeared before and after the 1955 flood indicated dramatic changes from 1940. The upper Elk River road, which parallels the mainstem, was constructed in the riparian area on the south bank. A combination of high flood flows, road construction and massive road failures, resulted in a major loss of several miles of riparian vegetation on the south bank. Because the mainstem is primarily oriented east to west, the south bank has the potential to provide approximately 95 percent of the stream shade. Vegetation accounts for potentially 62 percent of the stream shade with topography providing the remaining shade. The loss of shade trees and channel changes probably resulted in increasing summer stream temperatures on the mainstem of several degrees.

Today, the riparian area on the south bank remains altered from how it appeared prior to the 1955 flood. The riparian area below the road in several areas has revegetated with predominantly hardwoods. Hardwoods are not sufficient in height to adequately shade the mainstem during the sun's high solar angles in the summer months. The road's close proximity to the stream has permanently removed tall conifers that once provided stream shade.

The temperature ranges in the upper 60s °F and reaches 70°F at the fish hatchery, river mile 13, and river mile 22, just above Sunshine Creek. These temperatures are at or near the threshold where conditions become undesirable for fish. Below the Forest boundary the river is aggraded, with wide shallow stream reaches. Gary Susac, biologist with the Elk River State Fish Hatchery, reports that mainstem temperatures, approximately 5 miles below the hatchery, are critical–with measured values reaching 75°F in 1991.

Stream Flow and Response to Disturbance

Peak flows may be increased and the timing of peak flows changed by channel network expansion (increased drainage density) from inboard ditches along roads (Jones and Grant 1993). Channel network expansion was estimated based on inventory of 74 road drainage outlets, the mean ditch distance to the nearest drainage outlet(s) was 346 feet. The number of drainage crossings was counted from overlaying the road and stream networks. Because the smallest streams in the network are interpreted from maps and aerial photos rather than field mapping, these values are approximate.

Road surfaces have virtually no infiltration capacity, and road cuts may intercept slow subsurface flow and rapidly transport water through a ditch-culvert system acting as ephemeral stream channels. For the watershed area above the hatchery with 2.3 miles per square mile of roads, it is estimated that the channel network is expanded less than five percent. However, in some of the subwatersheds, the channel network expansion is much greater. In Milbury Creek, the most densely roaded area with 5.1 miles per square mile, the channel network is expanded by approximately 50 percent. The magnitude of increased peak flows resulting from these roads is unknown. The potential for effects from increased peak flow are the greatest in the subwatersheds where road density is the highest and the channel and stream banks sensitive to increased peak flows. Potential effects include increased channel erosion where stream banks are unstable (such as toes of earthflows and unconsolidated deposits) and a decrease in spawning success of some fish species.

Harvested areas can allow snow accumulation and a rain-on-snow event can result in rapid melting of the snow increasing peak flows (Harr, 1976). Less than 5 percent of the total watershed area is in the transient snow zone and a small percentage of this area has been harvested. Consequently, it is not likely that peak flows have been affected by existing harvest activities in areas that may be susceptible to rain on snow events.

<u>Channel Morphology and Response to Disturbance</u>

Changes in patterns of open riparian canopies are one indicator of channel response to disturbance (Grant 1991). Changes in riparian canopy were measured on six subwatersheds in Elk River using historical aerial photos. This technique does not detect aggradation or degradation when streamside vegetation is not affected, or minor changes in channel location or geometry. In addition anecdotal evidence was collected from long time residents.

Open riparian canopies along first- and second-order stream channels (class IV and III) increased 30-fold between 1956 and 1979, and were generally located along or near roaded or harvested sites. The greatest increase in openings were attributed to the 1964 storm, with 73% of the landslides and all of the surface erosion associated with roads or harvest. The average length of open riparian canopies from landslides entering these channels was 785 feet (240 meters). Most of the open canopies did not extend into a higher order channel. The length of open riparian canopies along fourth- and fifth-order stream channels (class I) did not change appreciably from 1956-1979 .

Numbers of gravel bars measured along the mainstem of Elk River from 1940-1986 aerial photos increased by 77% overall (Ryan and Grant 1991). In the upper segment with its wider and lower gradient, gravel bars increased more in size (which was not measured) than in number. In the lower segment which is narrower and steeper, a greater increase in the number of bars was observed. The most notable evidence of channel widening and an increase in the number and size of gravel bars occurred below the confluence with Purple Mountain Creek.

There is increasing evidence that the 1955 flood had a greater effect on channel morphology than the 1964 flood for many coastal northern California and southern Oregon streams. Aerial photography and oral history from the region indicate that high flows eroded channel banks and riparian vegetation considerably; interviews with long-time Elk River residents indicate that substantial changes to the lower river morphology occurred as a result of the 1955 storm.

Below the National Forest boundary, comparisons of the Elk River channel from 1940-1986 aerial photos show increased numbers and sizes of gravel bars, loss of riparian forest, and increased widths of active channel bars (Ryan and Grant 1991). Where the channel is unconfined as it flows through valley floor, the channel has shifted its location in some areas as much as 100 yards. In this low gradient valley floor, sediment was deposited, changing pool geometry/frequency and establishing dramatic new flood plains. These observations are consistent with local accounts of decreased pool depths and increased bank erosion.

<u>Fish Habitat Distribution and Populations</u>

We used Hankin and Reeves type stream surveys. In addition anecdotal evidence was collected from long time residents.

The Elk River supports one of the most important and valuable wild runs of anadromous fish in coastal Oregon. Today, the major anadromous salmonid species found in Elk River are chinook salmon, winter steelhead trout and sea-run cutthroat trout. However, at the turn of the century, the primary species may have been coho salmon according to long-time residents. Photos and anecdotal accounts indicate that habitat in the lower valley was well-suited for coho salmon. The lower river was heavily wooded with spruce and hardwoods, and had multiple channels, slow backwater pools, and numerous log jams.

Dramatic changes in habitat, particularly in the lower basin, may have been a major cause for the change in dominant fish species from coho to chinook salmon. The key habitat elements which are important for coho salmon no longer exist in the lower Elk, and present habitat conditions now favor chinook salmon and steelhead trout production.

For a basin of its size, the Elk River is one of the highest producers of chinook salmon in the Pacific Northwest. A total of 24.5 miles of stream within the upper basin are utilized by chinook for both spawning and rearing.

Juvenile steelhead trout production within the upper reaches and tributaries accounts for an estimated 70 to 80% of all steelhead produced in the system. Steelhead trout have the most ubiquitous distribution among the anadromous species; total miles used within the upper basin is 36.0. Densities in the North Fork have been estimated to be over 4,000 fish/1000 meters (PNW unpublished data).

Sea-run cutthroat trout and coho salmon also occur in various places and densities within the upper reaches of Elk River. Anadromous cutthroat have been found in all areas occupied by steelhead trout juveniles (34.0 total miles).

Sub-watersheds and Reach Scale

Elk River has six major tributaries with drainage areas known as sub-watersheds which range in size from 3000 to 9000 acres. Numerous smaller tributaries to Elk River (known as "facing" drainages) are grouped into lower, middle and upper areas. Tributaries help to maintain overall watershed fish production by distributing the effects of catastrophic, large-scale natural events. Natural events can affect different areas in the watershed at different times, and produce a mosaic of productivity with sub-watersheds at various stages of recovery.

Landslide and surface erosion
Landslide sediment yield varies among the sub-watersheds due to inherent slope stability and land use history. The total volume of delivered sediment has been divided by the area of the sub-watershed to allow meaningful comparisons.

The sediment input to the North Fork has been low over the inventoried photo period. Thick deposits exposed from downcutting of the stream have been dated as at least 83 years old. This large volume of sediment may have been deposited from transport of debris flows triggered by storms in the 1890s, following fires in the 1870s. These debris flows may have contributed to today's highly productive habitat by providing a source of wood for habitat structure and nutrients.

In Panther Creek a natural slide delivered an estimated 44,000 cubic yards of sediment to the channel, presumably from the 1955 storm. Considerable quantities of sediment have been delivered to the mainstem of Bald Mountain Creek, directly and via two tributaries which enter from the south from harvest on privately-owned land .

One of the most intense disturbances in the Elk River watershed occurred in the lower East Fork of Butler Creek in 1961. Within a single harvest unit of 330 acres, trees were clearcut from unsuitable lands and from riparian areas, roads were constructed in midslope locations and within the east fork, and a fire consumed the remaining ground cover. The resulting chronic gravel and debris avalanches buried the east fork channel.

Large Wood Supply
Both Bald Mountain and Butler Creek maybe seriously depleted in future large wood supply. There has been an overall reduction in potential large wood supply of 55 percent in Butler Creek, most of this on the East Fork. The East Fork is severely aggraded from timber harvest and road construction most fish habitat has been lost. Without a sufficient source of future large wood, recovery of this channel could be delayed for several decades.

Bald Mountain Creek is also of concern where 33 percent of the potential large wood supply has been lost predominately on private ground on the mainstem. Most of the harvested areas have revegetated as hardwoods. Unless there is an effort to restore conifers in these areas, more valuable fish habitat will be lost as chronic high sediment loading continues and future large wood supply is reduced.

Measured stream temperature at the mouth of Panther Creek reaches a summer peak of 65.5° F. From river mile 1 to the mouth the stream temperature increases 4° F. Estimates show that summer stream temperature at the mouth has increased 4° F from timber harvest in the upper part of the drainage. Without further disturbance, Panther Creek stream temperature is predicted to decrease at a rate of 1.6° F every 10 years.

Measured temperatures at the mouth of Bald Mountain Creek reach a summer peak of 67°F. Estimates show that summer peak stream temperature at the mouth has increased 6° F as a result of timber harvest and road construction. With continued harvest on private land and debris flows, it is speculated there will be little or no stream temperature recovery.

Measured temperatures at the mouth of Butler Creek reach a summer peak of 68°F. It is estimated that summer stream temperature at the mouth of Butler Creek has increased 7° to 8° F as result of timber harvest activities. The primary source of heating in Butler Creek is the East Fork located approximately 1 1/4 miles from the mouth.

Water temperatures as high as 78° F from the tributary mix with the mainstem of Butler increasing temperature from 59° F above to 67° F below the tributary. Without further disturbance, estimates show that Butler Creek's stream temperature at the mouth is decreasing at a rate of 1.4° F every 10 years.

Channel Morphology and Response to Disturbance
Comparison of channel surveys, channel changes in historical aerial photographs, estimates of sediment delivery and the channel capacity to transport sediment indicate how the channel has responded to natural and human disturbance. Figure x summarizes those findings for three subwatersheds which provide fish habitat to stocks identified as sensitive. The intent of the graphs are to display timing and magnitude of sediment loading to the capacity of the channel to transport sediment. These graphs act as indicators for when excessive sediment loading was occurring to better understand the current condition of the channel and project future trends.

Results indicate that the sediment transport capacity of the lower North Fork was only exceeded for a brief period in the early 1970's. Based on these findings, it is speculated that land use practices have not adversely affected the lower reach.

For Panther Creek results show that the large natural slide on the East Fork and road and harvest activity in the late 1950's through the 1960's created excessive sediment loading to the "productive flats" area on the mainstem. This probably resulted in loss of pool volume and the development of gravel bars. It is speculated that the low level of sediment delivery for the past 20 years combined with the ability of the mainstem to move sediment has allowed the channel to recover.

The sediment transport capacity of Bald Mountain has been chronically exceeded for the past forty years from harvest activity predominately on private lands. The excessive sediment loading to the mainstem has caused pools to fill and the channel width to depth ratio to increase significantly. These findings are consistent with field observations and fish surveys. It is speculated that the continued persistence of debris flows from road and harvest units may be affecting channel recovery.

Fish Habitat and Populations
Productive flats and low-gradient habitat are located in the North Fork Elk, Panther Creek, and Red Cedar Creek. These tributaries contain a larger percentage of unconfined reaches. Mean pool depth should be interpreted with caution, as it does not account for the substantial statistical variability. Increased channel confinement and higher stream gradient influences pool depth, but so does large wood in unconfined areas.

III. Condition Trends

Landslide and Surface Erosion
Future trends include continued disturbance on non-National Forest lands (in Bald Mountain, West Fork Panther and Middle Area tributaries), continued effects of past disturbances on National Forest and non-National Forest lands, and natural disturbances.

Landslide sediment delivery and surface erosion is expected to be much lower than that experienced in 1960 though 1980 as the result of reduced activity and improved land management practices. However, road maintenance will continue to decline as a result of designation of late

Sediment transport for N. Fork, Panther and Bald Mt.

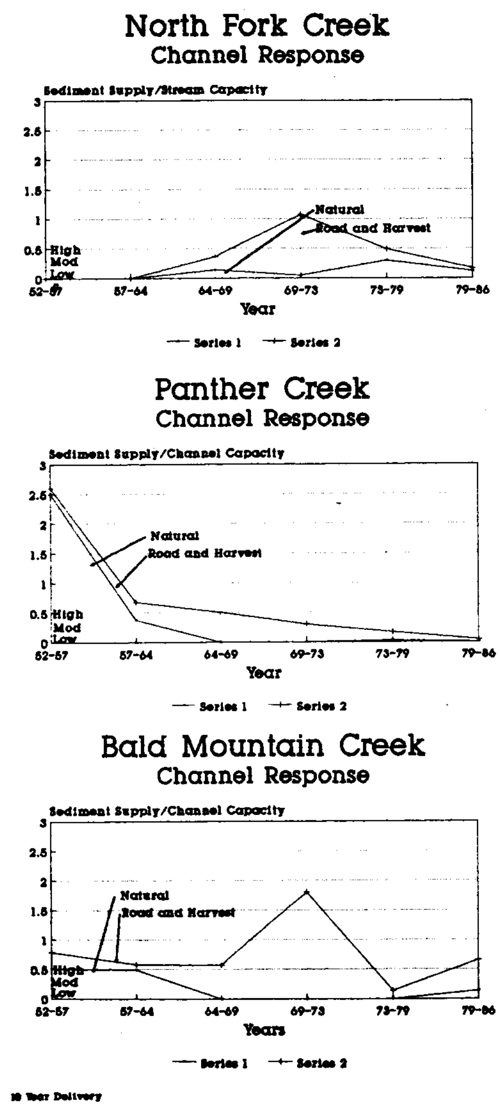


Figure 11

successional reserves and the greatly reduced timber road maintenance revenues in the watershed. Older roads will continue to fail and erode, increasing sediment delivery to the stream system. Some roads will remain open for access where required for legal access to privately-owned lands, for recreational and mining access, and for fire suppression. Landslide sediment delivery could be reduced if a comprehensive restoration program is implemented.

Large Wood Supply

Future trends include amount of large wood already delivered to the channel. Many areas previously harvested that potentially could have provided large wood will be in a state of recovery for the next 100 years as immature conifers grow. This includes approximately 27 percent of the total basin. For most areas there is sufficient large wood remaining to meet future needs. However, two subwatersheds may have long term effects from loss of potential large wood supply. Bulter maybe seriously depleted with approximately 55 percent of the potential large wood supply having been removed. Future recovery may be delayed as surface ravel and shallow failures slow establishment of new conifers. Bald Mountain has loss approximately 33 percent of its potential large wood supply on much of the mainstem which is privately owned. For Bald Mountain there may be little or no potential for recovery in some harvested riparian areas as hardwoods dominate these once conifer rich areas.

Riparian Canopy Disturbance& Stream Water Temperature

Overall, maximum stream temperatures in the mainstem Elk River have exhibited a decline following the large 1964 storm event (McSwain 1988). The three subwatersheds with elevated stream temperatures, Bald Mountain, Panther and Bulter Creek are expected to show a decline in summer stream temperatures as shade trees grow in harvested riparian areas. Estimated recovery rates range from a low of .5°F/10 years in Bald Mountain to a high of 1.6°F/10 years in Panther Creek.

Channel Morphology

The ratio of sediment delivered to stream transport capacity was shown for the three subwatersheds which were analyzed in detail. The historical condition may be compared with the projected future condition for both natural and road/harvest sources.

It is not known how much of the sediment which has been produced from natural and management-related disturbance has been stored behind large wood jams and gravel bars in the tributaries and mainstem above the National Forest boundary. Sediment which is deposited in the low-gradient off-forest reach is subject to transport down the valley. The valley floor is a long-term storage area which may also contribute sediment from streambank erosion. If the rate of sediment transport from the National Forest is increasing, channel widening and streambank erosion would be expected to continue. However, if the transport rate is decreasing in response to decreased production, the channel will again incise and create a narrower channel with deeper pools.

Two subwatersheds which remain most impacted by excessive sediment loading are Butler and Bald Mountain. Future recovery trends remain poor despite a decrease in sediment production because of depleted large wood supply and continued timber harvest on private lands in Bald Mountain Creek. Tributaries to the mainstem of Panther Creek are expected to continue to recover, creating deeper pools over the next two decades.

While overall channel conditions are expected to improve, if road maintenance continues to decline without closing and stabilizing unmaintained roadbeds, channel conditions could again decline, particularly in subwatershed with higher road densities.

Fish Habitat

The current habitat condition is expected to remain unchanged for the next several decades. The habitat for chinook, steelhead, cutthroat and resident trout is considered good for most of the watershed. Of greatest concern is the lost habitat for coho in the Bald Mountain subwatershed and the low gradient valley floor below the forest boundary. These low gradient areas are critical overwintering habitat for juvenile coho. Large amounts of sediment introduced into the stream most likely from timber harvest, road construction and private land development have filled deep pools needed for coho.

In Bald Mountain Creek projected chronic sediment from timber harvest and roads on private land will delay coho habitat recovery. With the reduction of potential large wood supply, another key element for coho habitat, the recovery rate maybe slowed further. Below the forest boundary, reduced sediment will help the formation of pools but it is uncertain what habitat recovery can be expected with the loss of riparian vegetation from private development and the high summer stream temperatures.

Restoration priorites include:

- Road Decomissioning
- Road pullback sites
- Riparian silviculture

IV. Logistics

The disciplines involved in this planning effort included:
Aquatics: Resource geologist, hydrologist and fisheries biologist.
Terrestrial and Social (not included in this paper): landscape architect, ecologist, planner and archeologist.

Watershed habitat and population data were generated from various stream surveys to interpret the resource values for salmonid habitat within the Elk River watershed. These surveys include those conducted by USFS PNW under the direction of Dr. Gordon Reeves from 1985 to 1991, and those conducted by Powers Ranger District (1988–1991). The assessment of resource value is summarized below.

		Fish Information:			Current Habitat Conditions @ Low-Gradient Reach							
Tributary watershed	Miles avail	Anad Species present	Pop'n size	Contribution to Elk Riv	P:R ratio	# pools	Lg wood/ pool	% pools >3' deep	Reach length	Winter habitat	Habitat Ranking	HABITAT VALUE
North Fork (to falls, 2 mi)		coho	high	High								
		chinook	high	High								
		steelhead	high	High								
		cutthroat	high	High			(54/44) =					
	2	res trout	high*	High	0.73	44	1.22	50%	1.25	exc	# 1	HIGH
Panther Cr (including 3 forks)		coho	mod*	High								
		chinook	mod	High								
		steelhead	high	High								
		cutthroat	mod	High			(18/32) =					
	5	res trout	mod*	Mod	0.68	18	0.56	44%	1.00	exc	# 2	HIGH
Bald Mt Cr (mainstem to falls)		coho	low*	Mod								
		chinook	low*	Mod								
		steelhead	high	High								
		cutthroat	mod	Mod			(77/59) =					
	7	res trout	mod*	High	0.64	77	1.31	39%	0.50	exc	# 4	MODERATE
Butler Cr (to forks)		coho	low	Low								
		chinook	low	Low								
		steelhead	mod	Mod								
		cutthroat	low	Low			(6/8) =					
	2	res trout	low*	Low	0.94	8	0.75	13%	0.25	poor	# 6	LOW
Blackberry Cr (above forks)		steelhead	mod	Mod								
		cutthroat	low	Low			(4/3)					
	2	res trout	low	Low	0.50	4	1.33		0.75	fair	# 3	MODERATE
South Fork (to Elk Lake side		coho	low	Low								
		chinook	low	Low								
		steelhead	mod	Mod								
		cutthroat	low	Low			(19/33) =					
	1.5	res trout	mod*	Mod	0.30	33	0.56	33%	0.50	fair	# 5	MODERATE
Middle face drainages		steelhead*	low*	Low								
	2.5	cutthroat	mod	Mod	n/a	n/a	n/a	n/a	0.50	poor	# 7	LOW
Upper face drainages		steelhead	low	Low								
	1	cutthroat	low	Low	n/a	n/a	n/a	n/a	0.25	poor	# 8	LOW

* Historically present in greater abundance
n/a = data not available

Elk River evaluation

kudos

- analysis extended beyond administrative (FS) boundaries
- used anecdotal accounts from residents
- considered desired future trends and a range of desired future conditions
- complete, logical flow from upland to aquatic
- localized problems through subwatershed analysis
- used models appropriately to validate field observations
- established clearly-stated objectives from the beginning
- clear use of two separate scales
- analysis process allowed for a lot of discovery

critiques

- need to scope social values to a larger degree
- did not include lower watershed or Wilderness Area
- need to expand terrestrial and social components to address FEMAT concerns

considerations

- need to allow more agency and public scoping to identify issues to address in the analysis
- need to be able to advise projects (regarding time and money constraints)
- need to make sure the analysis will provide enough information to answer the management questions (but how do you know?)

Elk River analysis summary

The Elk River analysis was designed to address specific issues relating to the area's Wild and Scenic River designation and to its management within the context of the Siskiyou National Forest Plan. Fisheries and water quality were considered as a key Outstandingly Remarkable Values (Wild and Scenic River Act terminology), and served to focus the analysis. Analytical objectives were clear and limited to those directly related to aquatic resources. The analysis considered aquatic factors within the entire Elk River basin, even though the issues in question were focused on the river corridor.

Major components of the analysis included landslides and surface erosion, large wood supply, stream temperature, stream flow, channel morphology, and fish habitat. Analysis of these components appeared well-conceived and logically executed. The mix of ground work, aerial photo analysis, and modeling seemed excellent, particularly the interpretations of these methods used to evaluate the implications of proposed alternatives for key issues, such as sediment.

The Elk River analysis also demonstrated a clean linkage among three spatial scales within the planning area boundaries. Aquatic processes were analyzed for both the entire Elk River basin (approximately 50,000 acres), and for several smaller basins within Elk River. These results were then used to identify needed projects and guidelines at the site-specific scale. Analysis methods and products appeared to be differentiated according to spatial scale, reflecting an appropriate level of resolution for each scale.

The analysis built on extensive datasets from previous and ongoing aquatic research, generated at least partly in response to the contentious nature of forest management in the basin. The public was involved through a formal EIS.

The Elk River analysis did not include many of the components seen as necessary for FEMAT watershed analysis. In particular, terrestrial vegetation, habitats and patterns, and disturbance regimes were not well-developed or integrated with the aquatic analysis.

Watershed/Landscape Analysis Workshop
Chichagof Island Analysis

NORTHEAST CHICHAGOF ISLAND ECOSYSTEM ANALYSIS AND PLANNING
TONGASS NATIONAL FOREST - CHATHAM AREA

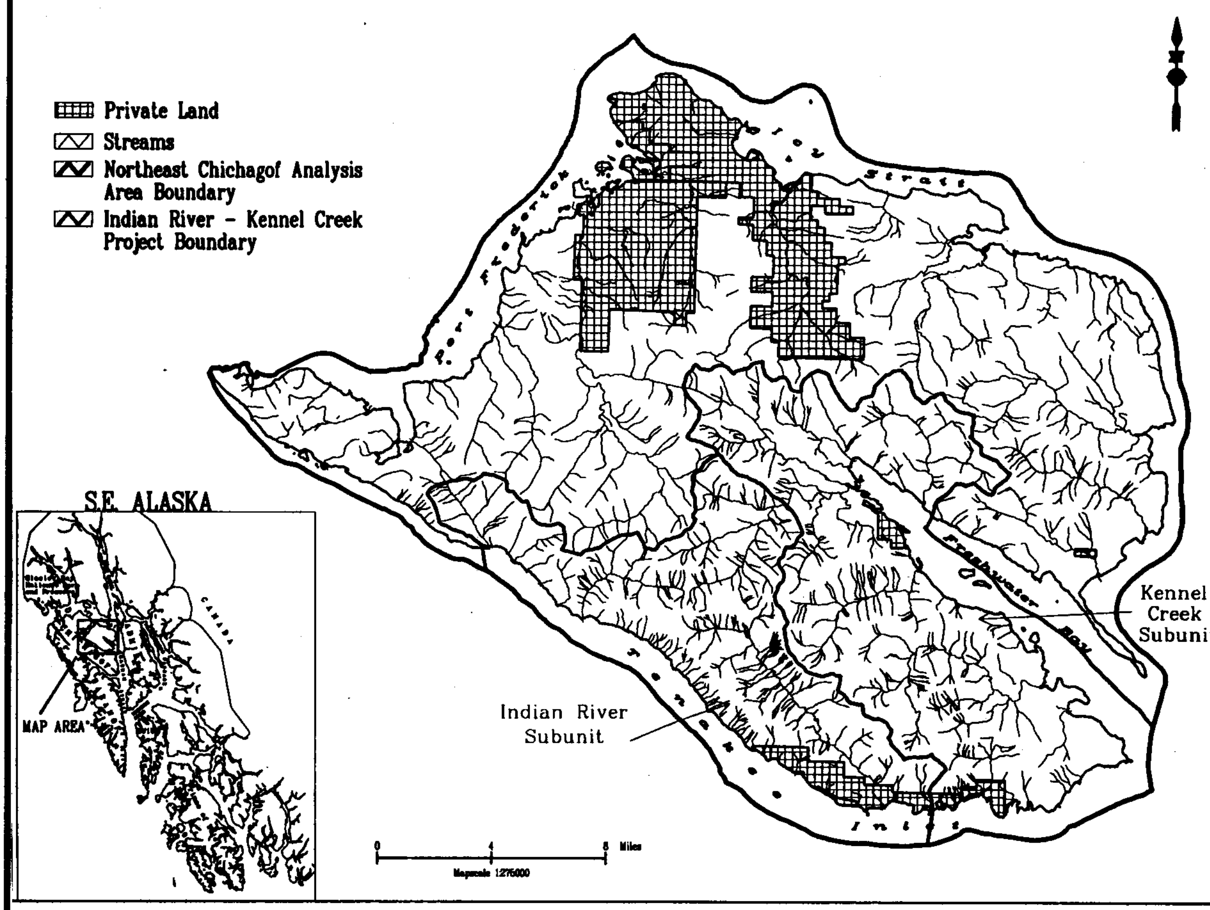


figure 12

Northeast Chichagof Island
Ecosystem Analysis and Planning Project

Jim Fincher, Ecologist
Steve Paustian, Hydrologist
Region 10 - Tongass National Forest
Chatham Area

I. Objectives

Introduction

The Chatham Area of the Tongass National Forest is taking an aggressive approach to incorporate ecosystem analysis and planning into the Alaska Pulp Corporation Long-Term Timber Sale Contract implementation process. The northeast Chichagof Island project is an effort to prepare a timber sale offering that is based on an understanding of how the project area and the surrounding landscapes function together as an ecological system. Watershed analysis is an integral part of this effort.

Northeast Chichagof is part of the Alexander Archipelago in the Southeast Alaska Panhandle. This peninsula consists of approximately 275,000 acres in 79 watersheds. The project area consists of approximately 112,000 acres divided into two subunits (Figure 12). The Indian River subunit consists of approximately 46,000 acres in 16 watersheds. The Kennel Creek subunit consists of approximately 66,000 acres in 18 watersheds.

The overall planning strategy calls for using a sustainable ecosystem management approach in the preparation of this timber sale offering. Therefore, the two primary objectives of this project are:

1. To conduct a systematic, interdisciplinary landscape analysis of northeast Chichagof Island in order to assess the importance of the project area in terms of it's role in maintaining ecological functions and biological diversity.

2. To prepare a landscape management strategy from this analysis for the Indian River/Kennel Creek project area.

Several timber offerings are in various stages of planning or implementation within the analysis area on Federal lands. These activities are captured in our analysis. Other activities that affect this analysis include harvest activities on Native selection lands and community development activities in the villages of Hoonah and Tenakee.

Higher order plans that are influencing the analysis include the Forest Plan, the Long-Term Contract with Alaska Pulp Corporation, Regional manual supplements on Best Management Practices and interpretation of the Tongass Timber Reform Act enacted by Congress. These plans, contracts, guidelines and legislation primarily address land allocations, product flows, and site or resource specific mitigation measures. They do a poor job of addressing future conditions in terms of desired landscape patterns.

Although official scoping has not begun, several meetings have been held to introduce the public to the project and its proposed management strategy. Citizens of Tenakee are taking an active interest in the project. A citizen group is working to establish a partnership in the mapping of karst features.

II. Analysis Process

National and regional documents outlining ecosystem management policy and strategy provide the basic philosophy, principles, and definitions that are incorporated into our analysis approach.

There are three basic features to the analysis process:

1. The analysis of ecosystem and landscape function, composition and structure is organized around six analysis elements:
   - characterization of the landscape,
   - assessment of biodiversity,
   - management indicator species habitat analysis,
   - old-growth fragmentation analysis,
   - assessment of landscape flows and
   - assessment of disturbance patterns and processes.

2. The analysis is conducted within a hierarchy of geographic scales:
   - ecological subprovince (northeast Chichagof Island, 275,000 acres),
   - project area (122,000 acres)
   - watersheds (5,000 - 15,000 acres)
   - subwatersheds (1,000 - 15,000 acres)
   - ecological land units (20 - 100 acres)
   - stands (10 - 100 acres)

3. The analysis considers three temporal scales:
   - pre-contract era dating to late 18th century
   - existing
   - the future out to 250 years

Although the Indian River/Kennel Creek project area is quite large it was determined that the analysis should include all of northeast Chichagof Island in order to assess the habitat conditions necessary to maintain the viability of certain wildlife species, especially brown bear and marten. Because of their need for large home ranges, issues such as habitat fragmentation, connectivity, etc. can best be assessed at this scale. Other analyses conducted at the ecological subprovince scale include: infrequent but large scale blowdown assessment, old-growth fragmentation, biodiversity analysis, geoclimatic variability and an evaluation of the draft Region 10 Habitat Conservation Area (HCA) strategy. The proposed HCA strategy is designed to provide for the maintenance of well-distributed, viable populations of wildlife associated with old-growth forests in southeast Alaska.

Watershed level analysis includes: riparian - wetland delineation and assessment; basin-wide sediment risk assessment; aquatic habitat condition assessment; and riparian blowdown risk assessment. Specific data used in watershed level analysis includes: stream inventories, ecological land unit inventories, existing vegetation inventory (TYMTYP), monitoring data, topographic feature data, land-use data, landslide and blowdown inventories.

Stand level existing vegetation information is used to characterize species composition, structural patterns, disease conditions, high frequency, small scale wind disturbance, and wildlife utilization.

The kinds of data used in the analysis fall into two categories: spatial and tabular. Mapped or spatial data is analyzed using ARC/INFO GIS modeling techniques. Tabular data is linked to GIS using relational databases constructed in ORACLE. Most of the data used in the analysis are from pre-existing inventories. Tabular data are also being analyzed using multivariate analysis techniques to determine corresponding or discriminating relationships between ecological factors. Updated information includes: wind mapping data, brown bear and marten telemetry data, fish species distribution and population sampling, riparian and aquatic habitat condition.

Private lands in watersheds within the project area were included in the analysis. Since most of these parcels were under federal management until recently, many of the existing resource inventories cover these lands. Aerial videography is used to update harvest activities on Native selection lands. It is assumed that existing harvest trends will continue on these lands.

III. Products And Results

Characterization of the landscape, old-growth fragmentation, wind patterns, and wildlife habitat conservation area strategy alternatives are displayed in map and data table format. Landscape characterization is displayed and evaluated at all analysis scales. Individual GIS layers used in landscape characterization includes geology, soils, landform, potential and existing vegetation. Old-growth fragmentation is displayed and evaluated by size and volume class. Near neighbor analysis is used to determine the influence of edge effects and identify the distribution and connectivity of core habitat. Prevailing wind patterns are mapped at the ecological subprovince scale. Correlation between prevailing wind patterns and natural and management induced blowdown patterns is being determined. Multivariate analysis will be conducted to identify the soil/site factors that appear to be the best predictors of blowdown risk. This will be incorporated into a GIS model used to delineate high risk areas within individual watersheds.

Sediment delivery risk is predicted by overlaying ecological land unit polygons having high or extreme mass wasting hazard ratings with each timber harvest unit and the transportation network. Sediment delivery ratings are then interpreted for each road segment and harvest unit that intersect mass wasting hazard zones based on criteria developed from landslide studies in SE Alaska and British Columbia. These ratings are attributed to proposed harvest blocks and road segments enabling rapid assessment of various logging system transportation alternatives.

This sediment risk analysis evaluates both the potential for landslide sediment delivery to major riparian areas via arterial drainageways, and the ultimate potential for direct sediment delivery from debris avalanches to mainstream and major tributary stream segments (determined from slope storage potential). The analysis procedure links headwater erosion and sedimentation risk zones with downslope riparian areas most susceptible to sedimentation impacts. Products include GIS plots that visually depict the location of high risk roads and harvest units. Tabular summaries of qualitative ratings for sediment delivery risk by harvest alternative can be readily developed.

Aquatic habitat features are summarized in a GIS lookup table for each channel type stream reach. Key habitat parameters include cover types, pool frequency, and LWD frequency. GIS analysis provides us with the capability to readily compare habitat data between various stream types and watersheds facilitating the comparison of ecological potentials to existing conditions. This information will be used to develop and prioritize fish habitat conservation and rehabilitation strategies.

Development of a desired future condition (DFC) that can be expressed in terms of a desired landscape pattern is the goal of our coarse level analysis of northeast Chichagof Island. The landscape management strategy for the Indian River/Kennel Creek project area will identify management activities that are consistent with moving this area toward the DFC. Desired future condition objectives will be developed from the integration of:

1) A habitat conservation area strategy that minimizes habitat fragmentation and maximizes connectivity within a timber harvest emphasis management area.

2) Identification of riparian reserve areas which includes areas with high sediment production risk.

3) Identification of other resource sensitive areas (e.g.. visuals, unique or unusual habitats).

Reports on analysis and product development are provided to the Area management team on a periodic basis. Work sessions and briefings are coordinated with individual Area and Regional staff groups to facilitate peer review of the analysis.

IV. Logistics

The core analysis team consists of a silviculturist, a FS wildlife biologist, an Alaska Department of Fish and Game wildlife biologist and an ecologist. Assistance and support is provided by Area and District specialists.

Two years have been programmed for coarse-filter analysis of northeast Chichagof Island, identification of DFC's and development of the landscape management strategy for the Indian River/Kennel Creek project area.

The funding of the project is averaging $300,000 per year.

Partnerships have had an important role in the field work and analysis process. The partners have provided skills and data not available on the Chatham Area. The partners include: Alaska Department of Fish and Game, University of Alaska-Fairbanks, Forestry Science Lab-Juneau, R10 State and Private Forestry, and Community of Tenakee.

Development of the complex models and analysis techniques would not be possible without advanced GIS analyst support. The Tongass possesses a comprehensive GIS system forest-wide. However, each Area has only one senior analyst. To expedite our GIS database management and analysis needs we have had to supplement local expertise with detailers. The team really would benefit from having a GIS analyst as a team member. Much of the intensive modeling and analysis can only be done on a workstation platform. However, the ARCVIEW software used on personal computers has been valuable because it does not require an extensive background in GIS to use as an analytical tool.

V. Conclusions

On the Chatham Area, Integrated Ecosystem Analysis is:

1) Assessing many ecological components;

2) Evaluating their interrelationships;

3) Using several spatial and temporal scales.

4) Producing a landscape management strategy that reflects an understanding of how a project area fits within a larger landscape.

Technical requirements

Data base validation and maintenance has demanded more time than initially estimated. Projects such as this really need to have a database manager and a GIS analyst with advanced skills. A workstation platform is the most efficient means for processing data at this scale of analysis.

Coordination needs

Coordination with Area and District specialists is absolutely necessary. We have been able to work together on many issues that has benefited their ongoing work and our analysis effort.

For partnerships to be successful a considerable amount of time must be dedicated to coordination efforts to assure that all parties concerned are satisfied with the working arrangements and product development.

Chichagof Island evaluation

kudos

• the web model of landscape strategy is useful because it is all-inclusive and can be expanded
• scale was used appropriately (the larger framework in which the analysis fit made it more easily accomplished)
• building up from landform to landscape process and response was useful and logical
• the analysis allowed enough time for coordination and cooperation with other agencies
• it included estuarine habitats and freshwater wetlands
• it included wildlife
• it made a full-time partner of the Alaska Department of Fish and Game, and involved several other agencies and universities
• it integrated ecological and geomorphic assemblages into planning units
• it included special features (e.g.. caves) and related them to landscape processes
• the management strategy was spatially-oriented

critiques

• timber volume has potential to drive the analysis
• need a better sense of how this fits into the larger context, particularly at the province level
• need to include political history (past and present land use and vision for the future)
• need to relate sediment to fish habitat

considerations

• need early involvement with the public; don't wait for the NEPA process
• need monitoring (particularly useful in an island ecosystem)
• need to articulate connectivity with marine ecosystems

Chichagof Island analysis summary

Northeast Chichagof Island of southeast Alaska provides an example of a wide ranging analysis of terrestrial, riparian/aquatic, and wildlife elements in a large scale landscape. It covers part of the Alaska Pulp Corporation Long-Term Timber Sale Contract area within the Tongass National Forest, and the project is part of the process which implements that contract. Midway through its two-year analysis phase, the project is intended to provide ecosystem analysis, identification of desired conditions, and development of a management strategy for subunits of the analysis area before preparation of a major timber sale planned for the third year.

Chichagof is conceptually the most comprehensive, multi-scaled, and integrated example presented at the workshop. The objectives of the Chichagof analysis are fairly similar to those of FEMAT Watershed Analysis. They are to integrate design of late successional reserves, riparian reserves, and resource sensitive areas into desired condition, as well as to provide information for fish habitat protection and restoration. Chichagof provides a good example of multi-scale analysis. For example, habitat fragmentation, connectivity, large scale blowdown events, old-growth fragmentation, biodiversity, and the draft Region 10 HCA system are evaluated at the ecological subprovince scale (Northeast Chichagof Island encompasses 275,000 acres). Private lands were included in the analysis.

It appears from the presentation that the team is completing characterization of the landscape, fragmentation, wind patterns, and wildlife habitat conservation area alternatives. Sediment risk analysis and aquatic habitat features have been summarized. However, the assessment has yet to be synthesized into a desired condition or landscape management strategy. It is not yet clear to what degree externally derived timber management objectives will drive landscape patterns for the area.

The project provides a strong example of partnerships including Alaska Department of Fish and Game, University of Alaska at Fairbanks, USFS researchers at the Juneau Forest Science Laboratory, the community of Tenakee, and other citizen groups.

The design of the analysis used a wide complement of biophysical elements, integration of field sampling, photography and videography, modeling, and use of GIS resources. Watershed analysis teams may well be sobered considering the scale of the project, the time frame, and the budget.

Watershed/Landscape Analysis Workshop
Regional Overviews

Landscape Analysis: the Rocky Mountain Approach

Miles Hemstrom
Region 2 Regional Office

The Rocky Mountain Region approach to landscape analysis is still in development, and this summary is a working draft of ideas. The Rocky Mountain Region is pursuing landscape analysis as a part of Forest Plan revisions and for Plan implementation. Our approach emphasizes the importance of context at several scales in both time and space. We hope to develop landscape approaches which deal with conservation of biological diversity through a combination of coarse assessments (generally habitat) and fine assessments (individual species and features). We are concerned that emphasizing management of individual species or features can result in conflicting and confusing management on the ground. We prefer to manage the entire landscape, as best we can, for all the biological diversity that exists there. To that end, we are developing ecological assessments that feed into the planning process (Figure 13).

At the regional level, we are accumulating integrated resource inventories and biological diversity assessments. Integrated resource inventories are conducted at the scale of land type and land type associations (National Heirarchy of Ecological Units) and depict the condition of existing vegetation, land, and water. Information at this scale is generally suitable for Forest and landscape planning, but is too broad for project planning. Biological diversity assessments include analyses of existing habitat, rare/unusual/unique features, and a historical context at the Subregion and larger geographic scales.

Using information from the biological diversity assessments, Forest Plan alternatives would be developed that reflect a range of conditions, depending on the issues addressed. All alternatives would use lessons learned from the assessments to help structure land management prescriptions in ways that approximate the composition, structure, and process of the "natural" system as closely as possible. Alternatives might be assessed by the extent to which the modifications they propose extend beyond the range of natural conditions.

We are hoping to use Forest Plan Implementation approaches developed by Region 1 (Helena NF, Elkhorn Mountains) and elsewhere to implement plans on a landscape basis (Figure 14). Landscape analysis involves refining resource information, including biological diversity assessments, for large areas (including watersheds) and defining project opportunities which move the land toward the desired future condition described in the Plan. This is not a separate decision step in the NEPA process.

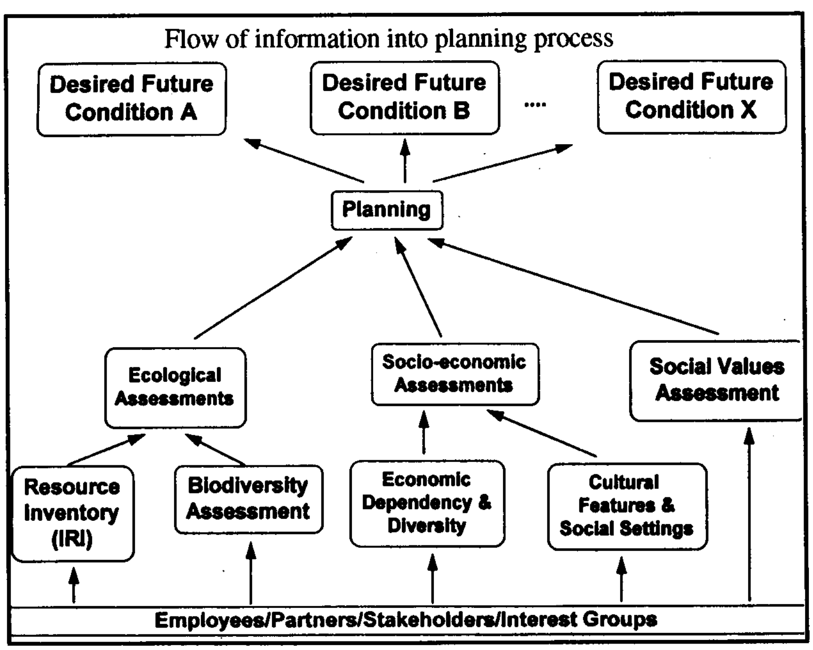


figure 13

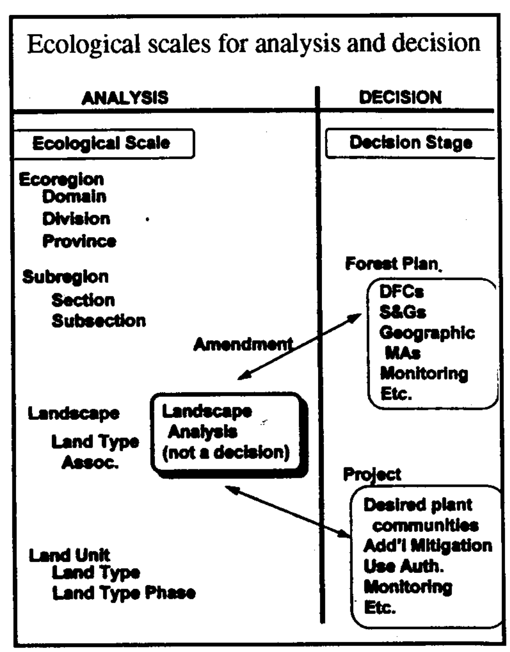


figure 14

Figure 15. Inventory of existing resources, Rocky Mountain Region, USFS

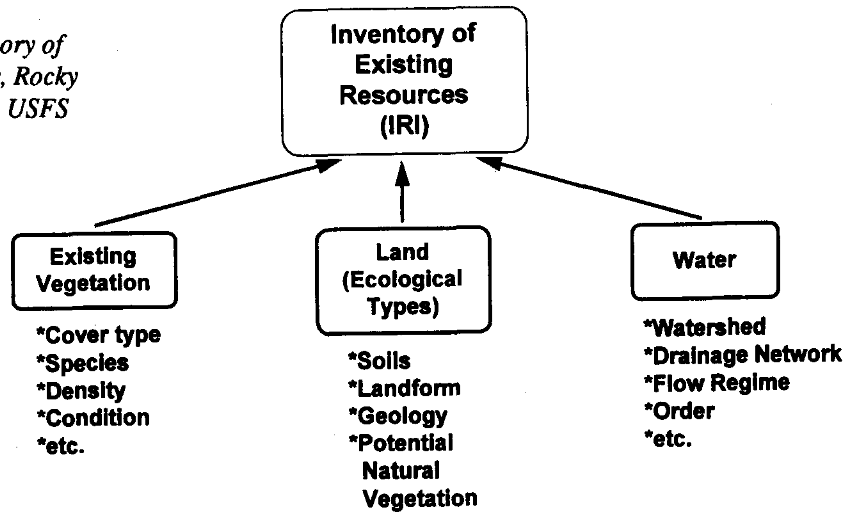


Figure 16. Biological diversity assessments, Rocky Mountain Region, USFS

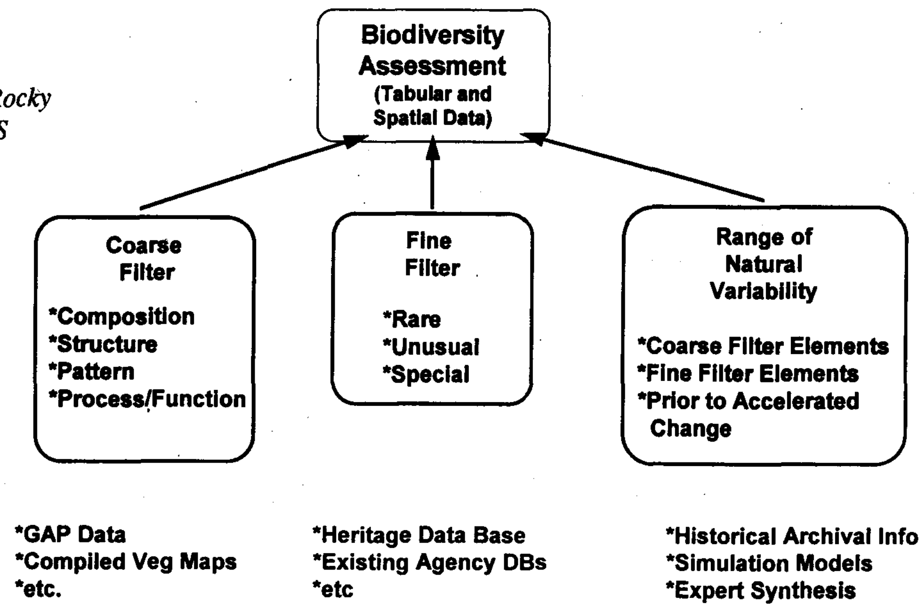
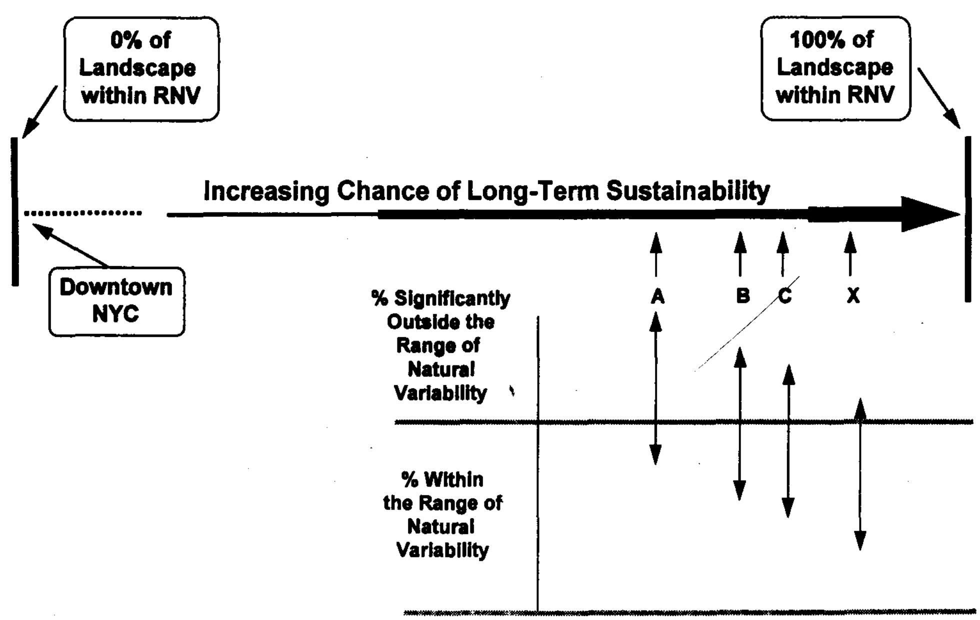


Figure 17. The relationship between ecological sustainability, the range of natural variability, and Forest Plan Alternatives



California Pilot Assessment Program For 1994

Robert Ziemer
Redwood Sciences Lab

Pilot River Basin Assessment
To develop the linkage between Basin Analysis and Watershed Analysis, a Pilot Basin Analysis of the Klamath River Basin will be conducted in 1994. The Ecosystem Restoration Office in Klamath Falls will take the lead and the Klamath National Forest will be the Forest Service coordinating unit for the Pilot Basin Assessment. Several of the Pilot Watershed Analyses will be conducted within the Klamath River Basin. This effort will explore the relationship between large basins (Klamath River), smaller sub-basins (Upper Salmon River and South Fork Trinity River), and watersheds (Grouse Creek and Butter Creek) and demonstrate the appropriate choice of scale for basin information while maintaining continuity of analysis.

The Klamath Province Interagency Implementation Team will provide oversight to the assessment. The Klamath Basin was identified as the pilot because it is data-rich and has the Klamath Province Restoration Team and Klamath Taskforce already in place.

Pilot Watershed Analysis
Representatives from the Klamath, Shasta-Trinity, Six Rivers, and Mendocino National Forests, BLM Ukiah District, and Redwood National Park identified 14 watersheds as possible candidates for the 1994 Pilot Watershed Analysis Program. Using evaluation criteria outlined in the following table, the candidate watersheds were prioritized and the following six watersheds were selected for the pilot analysis.

Arcata Area BLM
<u>Bear Creek watershed</u>
- Mattole River Basin
- Community involvement
- 19 square miles

Redwood National Park
<u>Redwood Creek watershed</u>
- Redwood Creek Basin
- Data rich
- State and private involvement
- Lacks Creek (BLM) included
- 270 square miles

Six Rivers National Forest
<u>Grouse Creek watershed</u>
- South Fork Trinity River, Klamath River Basin; Very data rich
- Within Hayfork Adaptive Management Area
- Key Watershed
- Mixed ownership, with large and cooperative owners
- 59 square miles
- Existing partnership with PSW for watershed analysis development

<u>Pilot Creek watershed</u>
- Mad River Basin
- Within Hayfork Adaptive Management Area
- Key Watershed
- Data rich
- Has Option 9-compatible ecosystem management project prepared to demonstrate ecologically appropriate Riparian Reserve design (Expected timber yield: 14 MMBF)
- 30 square miles
- Existing partnership with PSW for watershed analysis and forest carnivore studies

Shasta-Trinity National Forests
<u>Butter Creek watershed</u>
- South Fork of the Trinity River, Klamath River Basin
- Data Rich, existing Ecological Unit Inventory in GIS
- Key Watershed
- Ongoing EM pilot project, consistent with Option 9
- 34 square miles

Mendocino National Forest
<u>Middle Fork of the Eel River watershed</u>
- Eel River Basin
- Data moderate
- Key Watershed
- Mixed ownership
- 204 square miles

Klamath National Forest
<u>Upper South Fork Salmon River watershed</u>
- Klamath River Basin
- Data rich
- Key Watershed
- 184 square miles

NORTHERN CALIFORNIA WATERSHED EVALUATION TABLE

Watershed	Basin	mi^{2}2	DA	SS	Rst	Trt	Cur	Act	Pub	AMA	Own	Total
Middle Eel R	Eel	204	2	2	2	2	2	3	3		2	18
Blk Butte R	Eel	200	2	1	1	2	2	3	3		1	15
Thatcher Cr	Eel	30	2	1	2	2	2	1	2		2	14
Pilot Cr	Mad	30	3	2	3	3	3	3	3	1	1	22
Grouse Cr	Klamath	59	3	2	3	2	2	2	2	1	2	19
Redwood Cr	Redwood	270	3	2	2	3	2	2	3		2	19
Bear Cr	Mattole	19	2	1	3	3	1	3	3		2	18
Butter Cr	Klamath	34	3	2	3	3	1	3	3		0	18
China-Bridge	Klamath	31	2	0	1	1	2	2	2	1	0	11
Judd/Rusch	Klamath	47	3	0	2	2	2	1	3	1	0	14
Sailor/Eagle	Klamath	23	3	2	1	1	2	1	2		0	12
UpSFk Salmon	Klamath	184	3	2	2	3	2	3	2		0	17
Main Salmon	Klamath	94	2	3	2	3	2	3	2		0	17
Elk Cr	Klamath	94	3	2	2	2	3	3	2		0	17

River Basin		
Klamath R.	Klamath	12,100
Mad R.	Mad	485

Evaluation Criteria Used to Select Watersheds for Pilot Analysis Program

1) Data availability (DA)- (1-poor, 2-moderate, 3-good)
2) Number of stocks at risk (SS)
3) Restoration needs (Rst) (1-low, 2-mod, 3-high)
4) Existing condition threats (Trt) (1-low, 2-mod, 3-high)
5) Existing aquatic habitat condition (Cur) (1-low, 2-mod, 3-high)
6) Planned activity schedule (Act) (3-FY 94, 2-FY 95, 1-out year)
7) Level of public concern (Pub) (1-low, 2-mod, 3-high)
8) AMA within or adjacent (AMA) (1-yes, 0-no)
9) Ownership pattern (Own) (0-all one owner, 1-minor other ownership, 2-mixed owners, 3-multiple mixed

Mt. Hood National Forest
Large-scale Analysis Pulse

Glenn Sachet
Mt. Hood National Forest

In the absence of Province-level assessments, the Mt. Hood National Forest has undertaken a project to gather large-scale information to be used to plan future watershed analyses within the Forest. This short-term "pulse" of effort provides information at the Forest level to develop the ecological and human contexts of the Forest's watersheds. Products from this large-scale analysis will help define issues for watershed-scale analyses to follow.

Future watershed analyses will benefit from this contextual integration, and will prevent them from evolving in isolation. The pulse ensures that future WAs will be conducted in a comparable manner, with consistent interpretations of FEMAT direction and ecosystem management concepts.

The pulse is conducted by six teams, working simultaneously and independently for two months to collect the following information:

1. Ranges of natural conditions and current conditions for critical factors identified for each watershed during the Regional Ecosystem Assessment Project.
2. Biodiversity assessments focused on special habitats and species of concern.
3. Current conditions and those predicted to result from implementing the President's Plan and current Forest Plan.
4. Social landscapes, including access infrastructure, recreation and special use areas, water use areas, special forest products, illegal use and crime areas.
5. Natural large-scale processes (such as fire, wind, insects).
6. Information inventory.

Upon completion, a seventh team integrates the information from the pulse. They develop a descriptive summary of patterns, processes, and infrastructures from the Forest and analyze the effects on the Forest ecosystem of implementing the current management direction at larger scales.

The synthesis should help planners understand the most critical needs for restoration at a large scale and locate projects with the greatest opportunity for success. It also reveals gaps in protection of biological diversity and helps inform decisions about an overall strategy for delineating reserves throughout the Forest

Watershed/Landscape Analysis Workshop
Discussion Summary and Postscript

The Imelda Marcos Principle

Watershed/Landscape Analysis Workshop

Discussion Summary

This summary is a digestion of several wide-ranging discussions which occurred at different times during the three-day workshop. In order to provide continuity of thought, we have cut and pasted this collage of ideas to fit (more or less) the format the speakers followed with their presentations.

Introduction

Watershed analysis is an iterative process. It has grown through decades of experience, from cumulative effects analysis through SAT and FEMAT to the current pilot watersheds on federal lands. The Watershed/Landscape Analysis Workshop was the first effort to evaluate examples, not of textbook WA because none have been done, but of outstanding case studies of watershed and landscape analysis to find common points of agreement. None of the examples presented at the workshop fully define WA. This is no surprise, since each analysis was designed around different, separate objectives and preceded the FEMAT process. Nonetheless, they each bring to the table field-tested experience from which to draw the best ideas.

Objectives of WA

Defining WA through examples proved to be an elusive task. Each presentation demonstrated some aspect of watershed analysis as a mechanism to support ecosystem management. Elk River demonstrated a thorough riparian analysis; Augusta Creek a thorough terrestrial analysis; Chichagof Island illustrated analyses over multiple scales of resolution; Suttle Basin integrated overlapping analyses; and Tolt River involved all ownerships working in concert toward management action. As a component of the President's Plan, WA includes all these objectives with different emphasis to fit local needs. Additionally, WA will help focus planning by providing information specific to projects and will be used to integrate site-specific information into revised land management plans.

Above all, WA is a vehicle for ecosystem management at the watershed level. It not only links riparian and aquatic habitats to a full suite of processes operating throughout the watershed, it provides a common framework for evaluating and managing upland and riparian landscapes.

Some managers of federal lands may believe they have already accomplished the objectives of WA by establishing reserves as outlined by SAT and FEMAT; WA may seem redundant. However, the SAT and FEMAT guidelines were intended to be an interim process. If regional planning has already established default riparian reserves, WA will be the technical demonstration to test whether those reserves provide the intended level of protection to targeted species and processes.

Can WA do more than address aquatics? Most at the workshop concurred that, yes, a watershed is useful for addressing many questions of ecosystem management. Not only is a watershed nested in a hierarchy with links to larger and smaller scales, it is also ecologically defined, geographically limited, and includes most species. It is a conveniently sized planning unit, a scale which most people comprehend. However, only a portion of the potential range of WA was addressed by the workshop examples. Most workshop participants considered this a shortcoming, and urged the inclusion of upland processes and wildlife in future analyses. It should be noted, however, that not everyone at the workshop subscribed to this view. Some claimed that WA was overburdened with these other issues and ought return to a single objective: protect riparian habitat.

Many at the workshop cautioned that your objectives—whatever they are—may define a distinct set of questions which may make a difference to the conclusions drawn from the analysis. Is an analysis designed differently if its emphasis is timber production than if its emphasis is maintaining biological diversity?

Drawing from the presentations, it seems that *analyses can be designed from distinctly different management needs and still produce a broad ecological understanding of a watershed.* The information used to assess risk is the same information used to create future desired conditions. The fundamental management need of the Tolt River analysis was to locate areas where timber-cutting could occur with little or no damage to the watershed's aquatic resources. The Chichagof analysis addressed an array of issues to mitigate the effects of future, planned logging. The Augusta Creek example demonstrated how WA can be used to build a range of desired future conditions in proactive planning. The Suttle analysis demonstrated the possible integration of WA with Integrated Resource Analysis. Each of these examples began with information gathering in order to document the structure, function, processes, and interactions within each watershed. And in most cases, the analysis related to management needs and not to the goal of extensive inventory for its own sake.

Analysis process

Each analysis will use the professional judgment of its team to design appropriate techniques. There can be no strict method for conducting the analysis, but rather a framework of critical questions will guide the gathering of information.

Separate the tasks of analysis and planning
Both presenters and participants underscored the need to frame the analysis around questions that are appropriate and possible to answer. WA will not answer political questions. It separates the tasks of assembling information and making decisions. In Washington, WA is legislated by the state to include science and decision-making; it is a planning process based on site-specific scientific information. In the TFW model, the resource assessment is conducted by a team of scientists; crafting management prescriptions is a separate task where the scientists serve only as advisors.

On federal lands guided by NEPA legislation, planning begins when you take WA recommendations and build an array of management options. As with TFW, it considers tasks in a logical order: first is analysis—assemble information and understand relationships in context and scale; second is planning—site-specific proposed actions and alternatives designed through NEPA procedures.

Collaborate among stakeholders
WA provides a good environment for public collaboration because it is not a decision-making process; it provides opportunity for consensus-building before decisions are proposed and debated. It is an opportunity for shared learning among agencies and the public. And the public review of subsequent plans may go more smoothly if those groups or individuals who are likely to be critical are included as contributors to the process from the beginning. As an example, the California Biodiversity Council is initiating WA on all fronts from county-level to province and they are bringing in interest groups to help define the issues. And in Washington, the Tolt River analysis came to mutually agreeable decisions by sharing the analysis "open kimono" with all concerned.

This proactive collaboration provides a framework for interactions across a landscape of different jurisdictions and agendas , in contrast to reactive relationships of the past, particularly over T&E species. Most of the examples presented at the workshop demonstrate the value of interagency and public collaboration. Allow the time it takes to coordinate and collaborate with agencies and fellow specialists; they bring experience to the investigation, consensus to the analysis, and validity to the final product.

Part of the scoping that precedes WA should engage the talent and interest of the local communities. Increasingly, databases collected from private lands by knowledgeable groups or individuals fill information gaps on landscapes in mixed ownerships. WA would profit from specialists with extensive experience in particular watersheds.

Consider context and scale in time and space
To begin an analysis, it is essential to first understand the context of the watershed within the region. Questions framed in a larger context reveal the trends and bottlenecks among public interests, agency mandates, or large landscape processes. Relating the analysis to a larger context will help managers understand the priority of issues within the watershed and region. For example, regional and subregional ecosystem assessments, such as the Eastside Forest Ecosystem Health Assessment, are currently being used to set broad policy guidelines. The analysis should provide a level of detail comensurate with the scale and intensity of the issues in question. Different issues will require different levels of detail, but determining the appropriate level of detail may be at this point more a matter of finesse than science. Certainly the context in which many issues overlap is critical to analysis.

If, for example, coastal salmonids are listed, the scale of relevant analysis will increase immediately beyond that of single watersheds. Without context, all watersheds have the same importance; only with context will you know how to plan restoration projects. It is important to consider what happens to components before and after they flow through the watershed, particularly when siting restoration projects.

As a precursor to WA, a larger-scale overview can help plan specific analyses. The pulse conducted at the Mt. Hood National Forest provides a contextual overview, just as the box cover of a jigsaw puzzle shows how the pieces fit into the larger picture.

A WA must be linked not only to its context within the regional landscape, but also to the array of smaller scale processes it encompasses. The Elk River analysis demonstrated that consideration at a subwatershed scale can highlight a local critical concern that might have been overlooked (or overwhelmed) at a larger scale. This may include special landscape features, such as caves and their role in mineral cycling in the Chichagof analysis, or the dynamics of meadows included in the Augusta Creek example. The Suttle Basin analysis considered the context of landscape functions (roads, creeks, animal migration, wind) as they flow in and out of the watershed through time. In order to use WA to plan projects, the analysis must be designed at scales appropriate to support those projects.

The social and economic context of the watershed is integral to the analysis. WA should be placed in the context of regional demographics. What is the surrounding land use? Where are the cities? the population pressures? the development plans? Just as ecological components vary in their intensity at different scales, so do social and economic components. Small timber towns that lived and died on the flanks of federal forest land are growing rapidly now as city-dwellers abandon urban areas for the ambiance of a rural community. A large-scale shift in population is already underway in the West, putting new pressure on water and land use. To illustrate the potential of these demographic trends to overwhelm small-scale ecological planning, we were asked "are we so worried about the beetle crossing the road that we don't see the Mack truck heading our way?"

Synthesize results

All of the examples describe a process that allows specialists to work independently in their own disciplines, then brings them together to synthesize an analysis of watershed processes and connections. The intersection of disciplines is the place of great discovery. In each example, the beginning of the analysis is descriptive— how does a landscape work? what was its historic condition? what is its current condition? It is only when you interpret the potential of the site and describe a sustainable range of desired future conditions that you synthesize the information into a blueprint for planning.

The idea of a storyline, a logic train, is necessary to explain the key processes at work in the watershed and set them in the context of larger regional processes. To fully support subsequent planning, that logic train should be clearly documented and summarized to satisfy reviewers and critics, or if it must, to be defended in court. The Tolt River example uses the legal analogy of a "line of evidence" to understand how all the components fit together to form a logical path of cause-and-effect relationships, and "weight of evidence" to compare the relative importance and sensitivity of different components. When cause-and-effect relationships between land management practices upslope and stream condition downslope are provided to landowners, they are more likely to buy into subsequent management decisions. It is the line of evidence, rather than the bulk of data, that will be convincing. There must be detail enough to support the line of evidence and to convince most critics.

WA must be able to demonstrate logical methods and to predict the effect of management actions; but it must be used cautiously to project trends. Inevitably we will overlook the catastrophic or the insidious, events so large or so slow that they fall beyond our scales of measuring. Because we don't know where we are in many cycles, our analyses will always include a measure of uncertainty.

To be useful to managers, WA must offer more than a compilation of data. WA should include an interpretation of trends within and beyond the watershed. A succinct narrative summary will explain what you did and what it means better than volumes of compiled data. The causal mechanism reports described in the TFW model provide managers with a summary of the information that they need in order to write prescriptions. These reports describe the potential frailties of the site, and map the local constraints to roading and timber harvest. The "prevent or avoid" language used by TFW was designed to be intentionally vague but may be confusing to managers writing prescriptions. Does it mean "cut and minimize damage" or "do not cut"? The risk matrices of many analyses depend on more vague language, comparing levels of risk without reference points. If value judgments (high/med/low; good/bad/ugly) are used as an assessment, their fields of reference should be defined.

Logistics

Although the upcoming pilot watershed analyses were intended to be nested in different situations, common sense dictates that they be done where there are people to do them and information to build upon. WA must be accomplished in the most efficient manner to meet objectives as well as deadlines and budgets. Timelines are critical to limit the investigation and bring closure to the analysis. The Tolt River and Elk River analyses operated under a constrained time limit such as pilot watersheds will face. The President's Plan will require a watershed analysis before any harvesting can be done in key watersheds or riparian reserves. There needs to be a streamlined way to identify unique features and conduct the required analyses without spending years doing it. Many of the examples suggest that it is important to start with the information and skills you have at hand, scour everywhere for existing information, and be willing to skip the places where data are not available, leaving a place mark for another time to avoid bogging down.

Data management is the most time-consuming part of watershed analysis. Valid data analysis can only occur with efficiently managed numbers, so budget the time and money for data management from the beginning to streamline everything that follows. A GIS exists for most federal lands, which makes it possible to integrate a watershed analysis into a provincial or regional level analysis. But even on private land where data are not as extensive, some means to track information will make it possible to update assessments, adapt the analysis, and revise management decisions. This will be a necessary step for the pilot WAs.

Products and Results

WA must lead to planning decisions, otherwise it is simply an academic exercise. However, it is important not to promise too much with WA—*it is not a plan, it is analysis to support a plan.* To meet your objectives with WA, you must have a management planning process and a supportive political process already in place. WA cannot create these.

There is tension between the long- and the short-term needs that WA has been asked to address. Does the short-term need to refine boundaries of riparian reserves overwhelm the long-term need to develop a vehicle for ecosystem management? Will the need for reserves fade away with the application of ecosystem management?

One of the first decisions to be made following WA may be the design or modification of reserves. The workshop participants acknowledged the dilemma that either we experiment with WA to justify ecological changes in riparian reserve boundaries or we manage between the spaghetti. WA must be used to reconfigure the SAT boundaries. The lines drawn by nature are not arbitrary, but follow function; the lines drawn by managers are political, but can—and should—also follow function. Reserves are meant to protect ecological functions, and therefore *boundaries should be drawn to encompass function* and include restrictions that address the standards of allowable activities. It was suggested that these reserves would be better named "riparian function boundaries" to allow compatible activities based on site-specific analysis. However, without trust, they must be reserved from certain activities.

Trust, particularly in defining reserves, has to do with disclosure of objectives—reserved FOR what? AGAINST what? what kind of human behavior must be modified to protect the ecological value of the reserve? WA must address the lack of trust between public and agency, and between management and research. Full disclosure of the process and products of WA will help mend distrust. It also forces the analysis to come to closure with a measurable change on the landscape. Tom Atzet explained this as the Jane Fonda Principle: the only way to sell a product is with some before-and-after documentation.

Such documentation comes from monitoring. Although there is consensus that monitoring reinforces trust and verifies prescriptions, none of the workshop examples illustrate a strategy for monitoring following the analysis. Those involved in watershed analyses should lead the effort to *establish interagency standards for monitoring* in order to cut costs and collect usable, comparable information. This step will become more critical with the pilot WAs, in concert with the growing need for scientific review.

"Does the emperor have any clothes?" How do you know if the analysis has met its objectives? *Peer review should be a part of the implementation of WA.* To use an analogy from nursing, a wellness report would assess the health of the whole system, including the social component, and broadly describe a subject's history, condition, and potential. The storyline of cause-and-effect and the context surrounding the subject both should be part of the review. WA must be technically defensible in order to earn the trust of the public and of managers. Peer review will test that defensibility.

The workshop concluded with a list of general points of agreement to carry forward to the next round of watershed analyses. However, Atzet may have summed up the workshop discussions best with his Imelda Marcos Principle: we have to try on these shoes before we buy any more. The process of WA will be tested in the pilot watersheds. Let's see how well it fits.

Postscript

Gordon Grant, John Cissel, Cindy McCain

The workshop served as a reference point to evaluate examples of recent watershed and landscape analyses and test our current understanding. Clearly we already have good examples from which to draw the best ideas, and an emerging set of procedures, perspectives, and tools for future analyses. These include several approaches for analyzing critical issues (such as landslide hazards and channel conditions), new ways of depicting landscapes conditions and trends using GIS, and a few examples of applying WA to direct landscape design.

All five of the examples presented at the workshop were completed or well underway prior to FEMAT. This suggests that watershed analysis is consistent with existing planning structures (such as Integrated Resource Analyses) within federal and state agencies. These examples demonstrate that there is already an experienced cadre of specialists capable of developing and applying new methods. Even more importantly, the workshop demonstrated that people are still enthusiastic about the prospects of conducting WA on a large scale, despite uncertainty as to what the next steps should be.

General Agreements

The workshop highlighted general agreement around several key issues. First, there was virtual consensus that, despite having been spawned to address aquatic habitat concerns, WA involves more than the 'traditional' watershed issues of water, sediment, soils, and fish. *Implementation of WA as a vehicle for ecosystem management* requires a thorough assessment of terrestial vegetation, wildlife, and social components as well. This direction towards a more comprehensive view of WA has been clearly set for federal lands by the SEIS .

On the other hand, while there was agreement that WA is more than a process for defining appropriate riparian reserve boundaries, it was acknowledged that reserves will be one of the first issues analyses on federal lands will need to address. Workshop participants generally accepted that riparian reserves can be modified as long as they *maintain the same level of function* as indicated in the SEIS. This functional test needs to consider the full range of riparian zone processes and landuse activities occurring within the watershed. For example, a light partial thinning on an adjacent hillslope may permit a narrower reserve adjacent to the stream. Demonstrating a comparable level of function will be challenging and is likely to be contentious.

There was strong agreement that *watersheds need to be analyzed within their larger context* of regional, physiographic and/or large river basin settings. Many questions cannot be addressed at the watershed scale but require a broader perspective. However, organizing a multi-agency, multi-issue framework to accomplish this will be challenging. While FEMAT calls for physiographic and river basin planning, individual analyses will initially need to define their own context.

Challenges

Integration

Fundamental schisms are still present in the concepts and implementation of WA, and will probably require time, attention, and above all, experience to resolve. Despite common agreement that WA includes terrestrial, riparian, and social components, these remain poorly integrated, either conceptually or procedurally. Riparian and terrestrial processes can be analyzed independently, yet their interactions remain largely unexplored. How do management actions on the hillslope influence the function (hence degree of protection required) within the riparian zone, and vice versa?. The objective of protecting riparian areas may suggest one set of prescriptions while incorporating historical patterns of upland disturbance may suggest a contradictory set of prescriptions. WA teams will have to grapple with such contradictory issues.

Supporting decisions

What will all this analysis be used for? What products will result and how will they be relevant to management? The usefulness of watershed analysis for subsequent planning and decision-making may depend in part upon the level of integration and interpretation WA teams can accomplish. Limits on time and available databases may constrain integration and interpretation, and therefore constrain the potential products likely to result from these initial pilot WAs.

At a minimum, WA will produce a comprehensive look at ecosystem conditions, patterns, processes, and trends within the watershed. This state-of-the-watershed assessment will describe the overall condition of the watershed and the need or capacity for management activities. The broad context offered by this watershed assessment can be used to frame subsequent project or policy planning processes, and to establish coordinated monitoring programs. Each of the workshop examples accomplished this minimum watershed assessment, although none were as comprehensive as expectations seem to imply.

Realizing the potential of watershed analysis, however, requires moving beyond a description of the current watershed condition toward an interpretation of potential future conditions and associated management activities and guidelines. At the simplest level, this may be a brief description of the range of possible futures that appear likely to meet ecosystem management and SEIS objectives. WA can link these descriptions to general areas within the watershed according to ecosystem function and condition. Although the product from this exercise may be brief, it should force a synthesis of the watershed assessment information and a translation into terms relevant to management. Both the Suttle Lake and Augusta examples attempted this level of interpretation, and Chichagof Island seems headed in this direction.

A more developed approach may be to use analysis results to structure spatially refined descriptions of potential scenarios. These scenarios may depict different landscape patterns within the watershed that together describe a range of options consistent with management objectives. The spatial resolution of these descriptions should be directly linked to the scale of analysis, and be hierarchically linked across other scales, larger and smaller. A set of scenarios provides more definition for planning and decision-making and forces a greater degree of integration of watershed analysis information. However, even this degree of integration may require more time than these pilot WAs will have to meet their fiscal year deadlines. Of the workshop examples, only Augusta Creek attempted this level of interpretation, with significant involvement from the research community.

Given adequate time, interpretation can be further developed to evaluate the proposed set of scenarios. The strengths and weaknesses of each option relative to specific ecosystem management and SEIS objectives would provide managers with useful information for subsequent planning. Potentially, WA teams may make recommendations concerning the implemention of any of these approaches. None of the examples presented attempted to evaluate scenarios that describe potential future conditions.

The line between analysis and planning is fuzzy at best, but moving beyond recommendations to actual selection of a preferred future condition clearly crosses the boundary. Formal adoption of any recommendation coming out of these analyses obviously need to follow formal, accepted procedures under NEPA, NFMA and FLMPA.

This incremental integration of analysis results is only one possible use of WA, and assumes that an integrated picture of potential future conditions is desirable. Other approaches are clearly possible. WA teams may need to move directly to project recommendations from the initial state-of-the-watershed assessment. In that case, recommendations will be strengthened by the context of the WA and should be able to focus on short-term needs described in the assessment. In the workshop examples, both Tolt River and Elk River appeared to take this route.

WA teams will operate more efficiently if they spend time at the beginning to clarify the products they intend to develop. Riparian reserves may force the issue for some watersheds. Description of various riparian functions could be contained within the state-of-the-watershed assessment. To translate this assessment into redefined riparian reserves, however, means understanding what management activities the riparian areas are reserved from, which would require more developed integration of analysis results with potential future conditions. One option may be to build a matrix that cross-references riparian function with desirable or allowable management activities, tied to specific parts of the watershed. Such a relatively straightforward approach may not fully integrate landscape pattern and potential future conditions with riparian reserves, but may still be useful for short-term planning. WA teams will likely find other creative ways of applying WA at whatever their level of integration and interpretation.

Balancing economic and ecological tradeoffs

A fundamental debate remains over how to view human activities within the post-FEMAT landscape. There are those who believe that the current landscape is in such poor condition as a result of multiple anthropogenic insults that there is very little opportunity for further land use activities for the forseeable future. There are others who believe that, with intelligent analysis and planning, the landscape is capable of supporting both human and ecosystem needs. Watershed analysis presumes that there are still decisions to be made about what, where, and how timber harvest can go forward. However, assigning an acceptable level of risk may be difficult unless there is minimum agreement that *some* level of harvest should be permitted somewhere on federal lands. It is unreasonable to expect WA to resolve this debate; it can only help to articulate some of the tradeoffs involved.

An integral part of watershed analysis which has been given very short shrift to date is the economic assessment of tradeoffs. Without some idea of the relative costs and benefits of different protection and management schemes, management actions may turn out to be inefficient or unimplementable. A decision maker faced with an array of alternatives wants to know what all the tradeoffs are, economic as well as ecological. As a vehicle for ecosystem management, WA will need to address the full suite of human expectations for landscapes.

None of the presentations offered examples of a thorough social analysis. This may be due to the fact that a robust demographic/economic analysis must be conducted at a provincial or regional scale; an individual watershed may be too small to provide more than an assessment of local uses, values, and attitudes. In the absence of provincial analyses, it may be best to leave place holders for some of these elements and document whatever assumptions are made in the analysis regarding social and economic patterns. Soliciting public participation is no substitute for thorough social analysis.

Public participation

Public participation. Public involvement. Engaging partnerships. The rhetoric and requirements surrounding watershed analysis and ecosystem management are not enlightening. For the WA teams, public participation must provide three things. First, the public is critical for supplying knowledge of the area and its history, awareness of issues and their priorities, and potential records and data. Second, public participation may allow voluntary cooperation in assessing and/or managing watershed conditions on non-agency land. Third, public participation must attempt to ensure that the scope and detail of the analysis are satisfactory to the critics, whether those critics are potential appellants or part of a political constituency. This last item is a matter of trust.

Public participation is offered as the answer to gridlock. The expectation seems to be that if all parties go through an objective scientific analysis together that the results will be trusted and management decisions based on the analysis will be less controversial. However, pilot WAs will be launched without established expectations, and without an established framework from provincial assessments. The pilots' tight time schedule does not allow a stately courtship dance among interested parties. If too little time is spent with the public, there will be little ownership in the results. If too much time is spent negotiating issues, then the analyses will fail to meet their deadline at the end of the fiscal year. If the public holds too high an expectation of their influence on the decisions following the WA, they may feel betrayed if later projects are determined by political or economic needs at a regional or national scale. Local participation and agreement cannot resolve contradictions between local, regional, and national interests.

What sort of management decisions will be drawn from the results of the WA? How much influence will local concerns have on decisions affecting publicly-held watersheds? The best approach may be to engage participants in an analysis as an open-ended process. If there can be general agreement on how the ecosystem of the watershed works, then projects undertaken in the area will be debated on a common, ecosystem-based understanding. The pilot WA teams must assume that the widest range of options will be considered, that decision space will be large, that recommendations on desired future conditions should be as unfettered and wide-ranging as possible to achieve the goals for WA. But we must be clear that we do not know how the results will be used. And we must communicate that uncertainty from the beginning to all those who will be involved—public, interagency partners, and ourselves.

Taking action

Peer review

Resolving many of the remaining uncertainties of WA will require a process of review, at least for the first generation of analyses. Reviewers would be scientists and resource specialists who are themselves engaged in doing or developing WA but who did not participate in the specific analysis being reviewed. The purpose of the review would be to evaluate whether the analyses conducted were sufficient in scope, depth, logic, and quality of results to meet the intent of FEMAT. In other words, was the analysis 'good enough'? The inevitable question will be 'good enough for what?', and it will fall to the reviewers to interpret what 'good enough' means, in light of the ever-changing set of technical competence, societal expectations, and legal requirements.

In many respects, the workshop was a microcosm of a peer-review process, so it is worth looking at what we learned. One clear lesson is that it is not possible to review an analysis in any depth in an hour from an office. To examine methods, procedures, assumptions, logic, results in detail requires much longer, perhaps a full day per analysis. Otherwise, one is left with a superficial awareness of some of the issues, procedures, and results used in the analysis without a strong sense of how tightly the whole thing held together. Peer review will be a critical mechanism to restore public confidence in the ability of agencies to manage the landscape; a superficial review will not be seen as sufficient. The public will likely have a role to play in the review itself. We might begin to build a review structure around some of the questions posed to our presenters at this workshop (page 9).

One useful model for peer review might be the way complex cases are handled in medicine by a process known as *grand rounds.* Cases are presented sequentially before a panel of experts, beginning with basic information (context, setting) and extending through analysis (what was assessed and why?) to results (what was learned and what does it mean?) and application or prescription (what was done and why?). The panel then clarifies, probes uncertainties or weaknesses in the logic, and offers alternative explanations. The process is conducted openly with opportunity for other interested parties to participate. The results are a critical review of strengths and weaknesses and a higher level of understanding for all concerned.

In the same way that medicine, law, and other professions have developed standards of reasonable and appropriate performance to evaluate good practice in their fields, so will watershed analysts need to develop similar guidelines by drawing on examples of WA conducted across the region. This will require time and experience to emerge.

Data management

One of the primary goals of WA is to foster a much higher level of collective wisdom about how the landscape functions and how human activities can be nested within it. To achieve this goal will require new strategies and structures to support accumulating, storing, and transferring information gleaned from individual analyses, an infrastructure for data management that does not now exist. This infrastructure will need to be an interagency effort, coordinated within and across regions, to address data quality issues, and archive information. Developing this structure must proceed in parallel to analyses if we are to capitalize on these early efforts.

Moving forward

Where are we going? The bottom line from the workshop is that we're not going anywhere unless we get going; we need to get on with the task of doing WA. We have regional direction (FEMAT), some examples, some procedural guides, an enthusiastic, though increasingly impatient (and diminishing) workforce, a somewhat fuzzy set of objectives, and a slow but steady thawing of disciplinary boundaries. Clearly there's enough to get started. The pilot watershed program will provide opportunities for learning; we need to accept that some of these first analyses will be good, some will be less so. We will need flexibility in interpeting outcomes of these first efforts, although the examples presented at the workshop suggest we are technically well underway. Already, decentralized arenas of WA activity have erupted in northern California; other parts of the region may do well to follow suit. Regional oversight may be best focussed at helping to foster these hubs by coordinating activities, addressing data management needs and resources, setting up models for peer review, and providing opportunities to bring analysts together at intervals to share, critique, and learn from each other.

Closing comments

WA is one process for implementing ecosystem management; there undoubtedly will be others. We are already in a time of rapid change and shifting paradigms in natural resource managment. Surviving this time of change, both personally and institutionally will require us to embrace the challenging tasks being asked of us positively and creatively. The success of WA will, in many respects, be a litmus test of how well we can adapt to changing circumstances.

Watershed/Landscape Analysis Workshop
Appendix

Appendix A.
Workshop Participants

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Appendix B.
Small Group Reports

Group 1
Riparian Reserves

How do you rationalize/justify modification of interim widths of riparian reserves specified in FEMAT?
Fundamental concepts: (McCammon)

- Modification of riparian reserves must be viewed as a three-dimensional problem.
- Consideration must be given to multiple time and spatial scales when evaluating the changes.
- Development of a logic path and chain of evidence for the rationale for change is critical.
- Modification of riparian reserves can only be recommended if the resulting reserve design will maintain or improve the level of riparian function assured by the original interim boundary width.

How can the results of watershed analysis be used to define appropriate riparian and other reserves? At what scale and time in the analysis and planning process are reserves defined?
At the watershed scale, a strategic plan for RRs is developed and described. This plan can be mapped to show initial, generalized distribution of RRs based on the understanding and information developed through the analysis. The strategic plan can describe the role of RRs with respect to sensitive sites or existing conditions.

Final RR design and specification is done at the project/ site level based on the specific project proposal. The goal is to assure the maintenance or enhancement of riparian function (see below) and is a function of all factors affecting the individual components of riparian function.

What standards of uncertainty and risk are used to define reserves? How are tradeoffs among objectives resolved?
Mandating blanket levels of risk and uncertainty are not an option. Minimum requirement should be that proposed modifications be subject to a sensitivity analysis based on the critical issues identified in the watershed analysis. This sensitivity analysis should examine the consequences of inaccurately or inappropriately defining reserve boundaries. Key issues here are the distinction betweeen risk and uncertainty, and the occurrence of an event and its impact on some critical element.

How are upland and riparian land use conditions and future scenarios integrated in setting reserve boundaries? Does the intensity of upslope management affect the design of riparian reserves?
Riparian reserve design is based on the retention, protection or enhancement of riparian functions including:

- Connectivity
- Aquatic habitat (processes and structure, failures, LWD, temp, etc).
- Other wildlife habitat
- Riparian-associated and riparian- obligate species

For each riparian function, consider the evidence as to what parts of the riparian network are currently providing specific functions. Evaluation should include future conditions and riparian potential based on the context of the watershed and, potentially, adjacent watersheds.
Considerations for modification should be based on:

- Spatial distribution of specific function
- Redundancy
- Frequency of disturbance
- Known or inferred distribution of organisms
- Larger basin context
- Special or unique places or habitats

Riparian reserve boundaries are refined during project planning and will respond to the potential effects of he proposed activities. (Rubber boundaries will be reanalyzed for each activity—i.e. boundaries appropriate to a thinning will be re-examined if a clear-cut were to be proposed later at a subsequent time

How are the full range of species associated with riparian areas accounted for?
Watershed analysis will develop information about species and their utilization of the area (areas of critical concern, etc.) as well as a description of physical processes which influence the RR. The specific requirements of each species of concern need to be related to specific riparian function... eg, is the need associated with connectivity, moisture, shade, or specific habitat components. The specific functions of the RR relative to the species needs will determine the size of the RR needed to meet that need. This consideration also needs to be framed with consideration for different spatial and temporal scales.

Group 2
Scales

What is the appropriate scale for analysis?
FEMAT establishes the need for a Regional scale; it develops some analyses and sets some designs at that scale. It also establishes the need for analysis at the Province scale. Watershed analysis should fit into this context. Information needs vary at each scale. The issues for each watershed analysis might dictate how far out of the physical watershed the analysis needs to look for linkage. The appropriate extent of the context is determined by the set of issues defined for the watershed analysis. Each issue may have a different geographic scale.

The appropriate contexts/scales to consider are likely to be:
- Region
- Province
- Issues relevant to the particular watershed
- Watershed
- Sites at the project level

Watershed analysis needs to consider the largest scale necessary to frame the issues. Linkages to the larger landscape should be established at the next larger scale, as driven by the issues to be examined in the watershed analysis. Always step up to the next larger scale to frame the issues. You may need to go larger than that to adequately frame the issues.One of the main objectives of larger scale assessments is to avoid missing the "no-brainers;" that is those things that are obvious at larger scales but disappear at the watershed scale. If there is a basic set of information at the two larger scales (Region and Province), the amount of duplicated effort and inconsistency may be minimized as analysis proceeds in many watersheds.

The resolution necessary for watershed analysis depends on several things, and, consequently, must be set for each analysis as part of scoping the issues. Resolution depends on, at least, the variability in time and space of the processes considered, the degree of controversy associated with each issue, and the availability of resources to accomplish the analysis.

How can concerns and objectives developed at one level be used to guide analysis and planning at other scales?
The concerns and objectives at higher scales can frame the scope analyzed at the next lower scale. Higher level issues can be used to constrain the search for information, the kinds of analyses, and even the kinds of decisions possible at the next lower level.

Higher level concerns help prioritize decisions and emphasis at the next lower scale. For example, an understanding of the rarity of fish stocks at the Province level may frame and prioritize how that stock is viewed at the landscape/watershed level and how you spend scarce restoration resources. Higher level concerns may help the watershed team recognize opportunities not apparent at the watershed scale.

Information and analysis at lower scales may help validate or may surface the need to revise the assumptions/information (monitoring plans, for example) derived at the next higher scales. For example, watershed analysis can feed Forest Plan amendments and revisions. Watershed analysis can help refine and suggest changes to FEMAT. Analysis at smaller scales can surface issues not visible at the larger landscape scales, but which may be wide spread and important.

What time scales are appropriate as the basis for analysis?
Longer time scales put rare/unusual/cyclical occurrences in perspective. A purposeful look at longer time scales helps us get beyond our basic human perspective of a few years to a lifetime. The existing condition may be unintelligible unless the longer term cycle or occurrences are provided as a context.

It is important to look at historical (pre-historic and recent) context. How long or how far back depends on the issue or process at hand. Things which vary over a long time frame require a longer look back. Things which have higher variance usually require a longer look back to understand that variance.

To look back requires understanding those things which have fundamentally changed and which have no historic parallel; the introduction of exotic species, for example. These kinds of fundamental changes may require modeling approaches or the extrapolation of similar events in other ecological conditions.

The historic perspective is only one side of the coin. It can serve as a mental model for extrapolation into the future. The length of time projected into the future depends on the models, information available, and variability of the issue at hand. There may be a time involved in transition to a desired condition that would then extend far into the future, for example a transition via restoration to a desired future condition.

Projection into the future can help watershed planning forsee issues which can be dealt with at present to preempt future problems that would be intractable in the future. For example, analysis of population and demographic trends at a larger scale may help frame or prioritize watershed management to deal with future pressures to de-water the system for domestic purposes.

Group 3
Integration of ecological (terrestrial and aquatic) components

Social integration is the key (multi-owner, multi-agency, citizens)
•Mind set needs to be that of stakeholder...involved, engaged, working toward common goals with common strategy (example Suttle Lake)

Resource/process analysis needs to be conducted parallel in time as an integral part of the analysis.
• Full set of information needs to be brought together for systhesis (example Suttle Lake)

Use parallel reference points: (*good examples are in parentheses*)

1. Historic condition (Elk River; Augusta Cr)
   Current conditions (All presentations)
   Future conditions (Augusta projections and pictures)
      Include restoration possibilities
2. Integrate potential of the land
3. Disturbance regimes
      Natural, historic, and human-influenced
         Insects (Suttle)
         Wind (Chichagof)
         Fire (Augusta)
         Flood (Elk, Augusta, Tolt)
         Mass Movement. (Elk, Augusta, Tolt, Chichagof)
         Cutting/Roads (Elk, Augusta, Tolt, Chichagof)

4. Reserves—Should we or shouldn't we move or change reserve boundaries?
      Need multi-scale context and linkage established
      4 essentials for considering adjustment or analysis
         1. Aquatic (fish-sediment) (Elk, Chichagof. Augusta)
         2. Terrestrial habitats (Augusta)
         3. Special habitats (Chichagof, Augusta)
         4. Species at risk (Elk, Tolt, Augusta)

Group 4
Social integration

Questions of concern relative to the social arena...
- What is the role of the public in watershed analysis?
- What opportunities does watershed analysis provide for the public? the agency?
- What role does the watershed play in the social context? (geographic relation to population centers, resource dependence, role in social, economic, other aspects of people's lives)
- How do people interact with the watershed and its resources?
- How does the watershed analysis tie into NEPA, Forest plans and public involvement?

The conceptual model delineates the forest complex as including forest values (clean water, fish, wildlife, commodities, aesthetics, etc.); natural bio-physical conditions (a template of aspects that may or may not be important depending on the watershed); diverse ownerships (public - state, federal; private -small and large); and values and goals (local, state, and national).

The watershed analysis process can facilitate a "sense of community". The public is especially interested in the assessment, interpretation and story line, the resource objectives, and the overall plan. They are not as interested in the prescriptions to achieve the objectives. The delivery of forest values and environmental conditions is a key product. There will be value trade-offs with given actions or alternatives (i.e. local, state, national values). A structured process is needed.

Process

1. Have a first cut list of issues and values you expect to be of concern.
2. Need a list of items that will always be considered for assessment, data needs, processes, interpretation to identify state of current condition, and historic overview of how the condition occurred - includes bio-physical and social components.
3. Sharing of assessments/information with a complete group of players, "community of interests" - get all interested parties involved; set up system so that all who want can participate -facilitate participation.
4. Identify the issues with the "community". Issues not addressed initially are identified along with additional info needs. Assess and model to establish current status.
5. Establish the goals and objectives colectively for the area. They should be outcome oriented, explicitly stated and area specific. (technical folks - key)
6. Based on status, goals and objectives the managers establish a general management plan. The key is to separate the science/technical folks from the managers - takes tension out and gives both ownership in the process.
7. Review the plan as a "community".
8. Ask whether we have done what we said we would do. Did we achieve what we expected? Were our assumptions valid?

Will the product and process be technically credible and legally defensible?
- Is it results-oriented?
- Does it evaluate/address risk?
- How did we arrive at our conclusions?
- Did we touch on all the critical questions?
- Does it have a strong component of field testing - ie. check out hypotheses on the ground?
- Fundamentally, how would the science community approach the problem?
- Did we get agreement on the process, ie. TFW and the manual?

Is the process efficient? did it have...
- Team building, team facilitation, skills?
- A structured process?
- Organization and leadership needs determined?
- Commitment and a positive attitude?
- Data collection based on needs?

Appendix C.
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