EPA 910/B-94-005

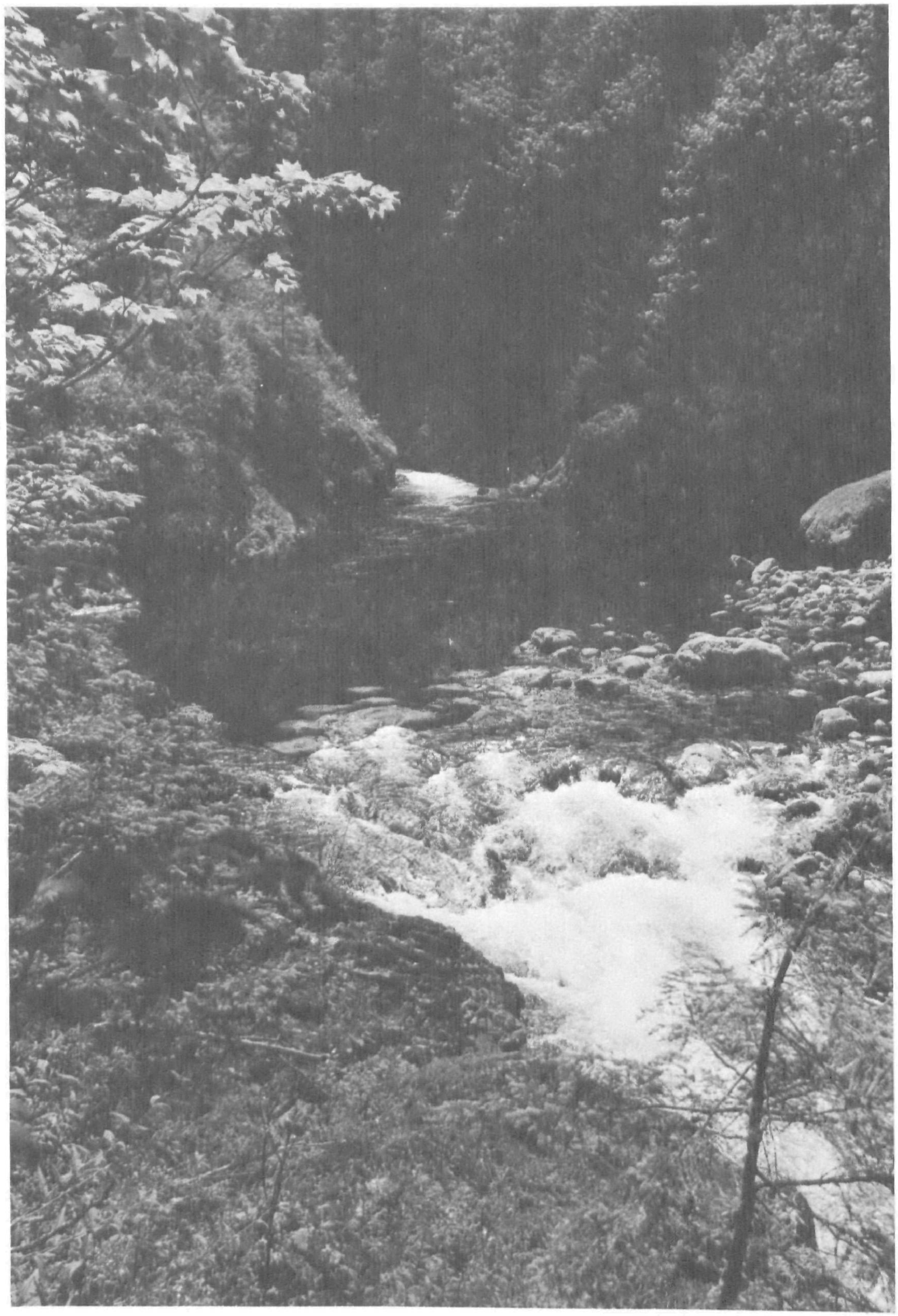
United States
Environmental Protection
Agency
Water Division

Region 10
1200 Sixth Avenue
Seattle WA 98101
Watershed Section

Alaska
Idaho
Oregon
Washington
December 1994

EPA

# A Watershed Assessment Primer



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# A WATERSHED ASSESSMENT PRIMER

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This report was prepared for Region 10, U.S. Environmental Protection Agency, Seattle, Washington, under EPA Assistance No. X-000650-01-5.

1994

**The information in this document has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement X-000650-01-5 to Oregon State University. It has been subjected to the Agency's peer and administrative review and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.**

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## ACKNOWLEDGMENTS

Input from technical specialists at universities and agencies was coordinated by the Oregon Water Resources Research Institute. Dr. F. Euphrat wrote much of the final report. K. Tarnow gathered background material and drafted some sections. R. Hildreth provided material on the legal basis for watershed assessment. S. Bauer, Boise, Idaho, provided the sections on grazing lands and on mining. Professor W. Huber at Oregon State University provided the section on storm water and urban watersheds. P. Cass and H. Van Zee provided the scientific editing; J. Preble and K. Bartron did the word processing.

Professors R. Beschta and S. Gregory at Oregon State University and L. MacDonald and J. Stednick at Colorado State University provided materials on specific methods and on evaluation of methods used in forested landscapes. Dr. C. Frissell, Oregon State University, provided evaluations of the methods based on selected criteria. Dr. G. Grant and Dr. F. Swanson, U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, B. McCammon, U.S. Forest Service Region 6 in Portland, and W. Megahan, National Council of the Paper Industry for Air and Stream Improvement, provided material on cumulative watershed effects and on how cumulative watershed effects analysis is being used. Professor J. Scott, U.S. Fish and Wildlife Service, University of Idaho, provided information on gap analysis. Professors J. Boyle, H. Li, J. Good, R. Jarvis and W. McComb at Oregon State University provided evaluations of different methods for assessing watershed conditions. Individuals with responsibility for land management decisions in agriculture, Forest Service, BLM, Parks Service, and Indian Tribes gave information on methods they use and land management changes on the basis of watershed analysis.

The workshop "Stream Habitat – Application of Geomorphic and Ecological Principles" at Oregon State University, January 26–28, 1993 provided the opportunity for input from Dr. J. Karr on the Index of Biotic Integrity, Dr. K. Sullivan on the TFW process, and K. Jones on the Fish and Wildlife Service watershed assessment.

Members of the Project Steering Committee outlined the study and posed the questions that needed to be considered. The members were:

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- Jim Weber, Columbia River Inter-Tribal Fish Commission, Portland, Oregon; and
- Roger Wood, Oregon DEQ, Portland, Oregon.

Members of the Technical Advisory Committee for this project reviewed drafts, and provided detailed written reviews and comments during a meeting on April 28, 1993. Members were:

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- Bruce Cleland, Risk Evaluation Branch, EPA Region 10, Seattle, Washington;
- Fay Conroy, Water Quality Engineer, Washington Department of Transportation;

- Tom Davis, Montgomery Engineers, Beaverton, Oregon;
- Dave Duncan, U.S. Bureau of Reclamation, Boise, Idaho;
- Jim Ferguson, Alaska Department of Environmental Conservation;
- Gary Gallino, U.S. Geological Survey, Portland, Oregon;
- Karl Gebhardt, Bureau of Land Management, Boise, Idaho;
- Richard Harris, SEAlaska Corporation, Juneau, Alaska;
- Christine Kelly, Watershed Section, EPA Region 10, Seattle, Washington
- Paul Ketchum, 1000 Friends of Oregon, Portland, Oregon;
- Mike Kuehn, U.S. Forest Service, Region 10, Juneau, Alaska;
- Hiram Li, American Fisheries Society, Corvallis, Oregon;
- Clarence Maesner, USDA-SCS, Portland, Oregon;
- John Marsh, Northwest Power Planning Council, Portland, Oregon;
- Bruce McCammon, U.S. Forest Service, Region 6, Portland, Oregon;
- Dale McCullough, Columbia River Inter-Tribal Fish Commission, Portland, Oregon;
- Michael McIntyre, Idaho Division of Environmental Quality, Boise, Idaho;
- Walt Megahan, NCASI, Port Townsend, Washington;
- Peter Paquet, Northwest Power Planning Council, Portland, Oregon;
- Alisa Ralph, U.S. Fish and Wildlife Service, Olympia, Washington;
- Dick Robbins, Portland Water Bureau, Portland, Oregon;
- Ken Stone, Washington Department of Transportation, Olympia, Washington;
- Rick Stowell, U.S. Forest Service, Region 1, Missoula, Montana;
- Bolyvong Tanovan, U.S. Army Corps of Engineers, Portland, Oregon;
- Howard Thomas, USDA-SCS, Portland, Oregon;
- Ivan Urnovitz, Northwest Mining Association, Spokane, Washington; and
- Larry Wasserman, Skagit System Cooperative, LaConner, Washington.

# EXECUTIVE SUMMARY

If water is to be available for various beneficial uses, it must be protected from non-point source pollution resulting from different land uses. Effective protection strategies are specific, goal-oriented management techniques based on watershed impact assessment. This report reviews the basis for watershed analysis and different watershed assessment systems, distinguishing between inventories and predictive models. The report summarizes several innovative systems and includes references and brief analyses of underlying concepts and methods of assessment. Some examples of watershed management based on assessment are given.

Watershed assessment, focusing on beneficial uses, may concentrate on either the stream channel, the watershed terrestrial ecosystem, or both. Assessments must be appropriate to the beneficial use, the size and time scale of events which degrade that use, and the time, money, and expertise available to the watershed assessors. It is important that assessments include all parties and interests within a given watershed; ecologic and hydrologic processes are not bound by property lines. Watershed management decisions affect lands beyond the immediate set of owners.

The cross-property ramifications of watershed assessments and decisions are rooted in the nature of watershed beneficial uses. Most watershed uses are downstream from the source of the impacts. These uses cross property and jurisdictional lines. People who are affected by these impacts often have little power to change upstream uses except through state or federal legislation.

The federal basis for analyzing entire watersheds in both assessment and management is contained in numerous statutes, most notably NEPA, the Clean Water Act, and the Coastal Zone Management Act. Additional strength for this approach is found in the Endangered Species Act. A key watershed concept in these laws is concern over cumulative effects. In watersheds, cumulative effects are driven downstream and downhill, are generated by a variety of human actions, and may affect the entire array of beneficial uses.

Existing water quality measurement systems are often adequate to assess watershed impacts for particular beneficial uses. In other cases, where pollution effects derive from multiple sources and affect a range of beneficial uses, more stream- or land-oriented assessment systems are appropriate. Such systems are particularly appropriate in cases of habitat degradation.

Assessment systems can be seen as part of a larger prediction and monitoring program. Assessment, analysis, implementation, and monitoring of results are all necessary in validating predictions. Monitoring the effectiveness of watershed programs allows managers and the public to witness not only the degradation, but the watershed improvements as well. Adjusting subsequent management based on effectiveness of previous results is called "adaptive management," which is an explicit part of some watershed assessment approaches.

Adaptive management assumes that there is uncertainty in predicted watershed responses. In order to reduce overall risk, some assessment systems identify critical habitats with higher relative risk to the watershed, to species, to beneficial uses, or to society. Systems that couple new management strategies with previous results allow more meaningful decision making under uncertainty, with feedback to allow managers to change programs and improve the results over time.

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# 1. INTRODUCTION

## 1.1. WHY WATERSHEDS?

Every land area on the planet is part of a watershed. Rain and snow falling on land feed streams and replenish groundwater. Precipitation onto water surfaces, such as lakes and rivers, also enters watershed flow. As water moves in surface or subsurface flows, it combines into progressively larger streams and rivers, local water tables, and regional aquifers. Because flow paths are not discrete and there is significant interchange between groundwater and surface water flows, watersheds are a useful level for organizing both assessments of water quality and responses to water pollution.

Watersheds are the sum of their surface features of hillslopes and channels, and their underground flow paths. Water precipitates as rain, snow, hail, fog, or dew from the atmosphere. Some water is evaporated, some transpired by plants, some held in the soil by capillary action, and the remaining "surplus" water moves "downhill" in response to gravity. Water flows along paths created by plants and animals, soil processes, the underlying geologic structure, and the water itself. Water alters its flow paths, and ultimately determines the channels of streams, the courses of rivers, deltas, valleys, and hillslopes. The power of water moving downhill allows it to suspend material. Water also dissolves material.

Watersheds support all human land uses, from wilderness area to city. People alter the nature of watershed surfaces and flow paths, change the volume of flowing water and groundwater, and add particles and solutes to water. Water pollution occurs in watersheds. Atmospheric water can carry pollutants that fall with precipitation and affect local water quality. Falling rain and melting snow move downhill as water driven by gravity, carrying both particles of and chemicals from plants, animals, soil, rock, and applied compounds. Many of the human-induced changes restrict other uses of the water, and conflict with established and future "beneficial uses." Table 1 shows a range of land uses and the pollutants that may be associated with them.

**Table 1. Watershed Land Uses and Associated Non-Point Source Impacts**

| Impacts | Land Uses | | | | | |
|---|---|---|---|---|---|---|
| | Urban | Mining | Farming | Range | Forestry | Wilderness |
| heavy metals | x | x | x | | | |
| low flows | x | x | x | x | x | |
| nutrients | x | | x | x | | |
| oil, grease | x | | x | | x | |
| pathogens | x | | x | x | x | x |
| peak flows | x | | x | x | x | |
| pesticides, herbicides | x | | x | x | x | |
| sediment | x | x | x | x | x | |
| solvents | x | x | x | | | |

When pollution occurs on watershed surfaces, it travels downhill or downstream until it is trapped, destroyed, or reaches the ocean. Trapping mechanisms vary as widely as pollution sources, and include consumption by biota, adsorption onto soil particles, and settling in waterways. Pollutants trapped in sediments stored in a stream channel may later be re-entrained. Biological or physical processes may break down pollutants, reducing them to beneficial, benign, or harmful constituents. Transport into the ocean remains the fate of those pollutants not otherwise entirely consumed or trapped.

The transport of water pollution components downhill and downstream is a watershed *process*. The environmental impact from those pollutants becomes part of the watershed's *condition* and may feed back into the watershed's processes. To maintain or improve water quality, we need to assess problems, develop responses, and predict changes at the watershed level. This is a new perspective on an old task: we already assess streams for fisheries, water for chemistry and pathogens, and soil for fertility. The new perspective is one of integration, combining existing data collection methods within a new framework of analysis.

Not all environmental pollution problems are amenable to watershed analyses. Smog, for instance, has water and vegetation quality impacts, but is transmitted through "airsheds." Migratory birds may be the unwitting targets of heavy metal contamination, and concentrate it within their migration corridor. Subsurface water transmission within volcanic areas may not follow surface watershed boundaries. These examples suggest that it is important to be aware of the bounds of the environmental problem before beginning any analysis, and that while watershed assessment may be more inclusive than many other systems, impact analysis demands good observation and clarity in problem definition.

## 1.2. WHY WATERSHED ASSESSMENT?

The impacts affecting water move downstream, commonly as sediment, turbidity, heat, or chemicals. In addition to specific pollutants, changes in the volume and/or timing of flows are also impacts. These impacts do not occur in isolation, but act together.

The concentration of effects may create secondary impacts which maintain or expand through positive feedback. An urbanized area, for example, may have oil and grease from streets, increased water temperature from reduced riparian cover, and increased peak flows from paved surfaces discharging directly into channels. In this example, increased flows erode banks increasing the volume of flow with the bank material itself; the increased flow then further erodes the banks. Chemical impacts from oil and grease, increased evapotranspiration from increased temperature, and undercutting banks from erosion all combine to limit revegetation and reduce riparian cover. Streambank erosion rates are determined by the combination of impacts. This combination or concentration of individual upstream impacts on a downstream site is considered a *cumulative impact*.

Downstream management may also create upstream effects. Anadromous fish, for example, which rear inland but grow in the ocean, may no longer be able to migrate upstream, die, decompose, be eaten, and have their nutrients redistributed across the landscape. At an ecosystem level, this severs the nutrient flow from the ocean to the terrestrial watershed. This kind of ecosystem-level impact has the potential to be severe over large areas and long time frames.

As with upstream effects, downstream impacts may, in combination, become cumulative. The combination of upstream and downstream impacts may also generate cumulative effects on habitats, species, ecosystems, and watersheds. Impacts on anadromous fish provide an example of a joint-upstream/downstream cumulative effect, with impacts from dams, fishing, and pollution affecting the fish downstream, and increased temperatures, increased sediment, and decreased woody debris affecting fish habitat upstream.

We are not concerned as a society with all resources. We choose to emphasize those particular elements of nature, in this case water and watersheds, that have "beneficial uses" for us. The protection of beneficial uses has been codified in a set of laws in the United States, focusing specifically on water, species, coasts, and less specifically on "the environment." States can develop additional standards with enforcement provisions for the maintenance of water quality and beneficial uses. In general, the federal government has delegated primary responsibility for water quality monitoring and enforcement of water quality standards to the individual states. The Clean Water Act of 1972, with its amendments, directs the preparation of plans for the control of non-point source (NPS) pollution (sec. 208) and for a holistic approach to NPS pollution management (sec. 319). The U.S. Environmental Protection Agency (EPA) recognizes that a holistic approach to watershed pollution requires inclusion of both non-point and point sources.

This report will present an array of strategies with which to assess both NPS and point source pollution at the watershed level. The report does not propose a "magic bullet" with which to assess watersheds. No single best method exists. Instead, this report will offer examples of watershed assessment procedures and guidelines to help assessors select an appropriate system. In all cases, watershed assessments must be based on recognized or anticipated beneficial uses, measurement constraints, institutional constraints, and implementation constraints.

These constraints suggest where headway must be made if "better" analysis or implementation is to occur. Yet these constraints have sometimes been quite inflexible because watersheds are large and complex, owners feel strongly about private property rights, good science is expensive, good regulation is both difficult and expensive, and not all players are interested in either fairness or outcomes based on public interest. Local expertise in watershed history, beneficial uses, current impacts, and present management will also be crucial in developing an assessment strategy.

One can assess watersheds from many points of view. Assessment and management of these complex landscape units is an expensive and important undertaking, and it is critical that users and owners cooperate prior to the assessment. The choice of assessment method is a critical step because, in isolating the problem, the assessment can pre-determine the range of possible management remedies.

This report concludes that continued monitoring and refined assessment should follow any management changes. Continued assessment completes the cycle of "adaptive management," allowing managers to both respond to mistakes and to receive recognition for successes. Inventory procedures are useful; repeated inventories to fine-tune management decisions are extremely useful.

## 1.3. The Audience for this Document

This document is for people who may need to conduct a watershed assessment because they need to inventory, analyze, and reduce impacts to fisheries, structures, water quality, or aquatic or terrestrial ecosystems. Because water pollution flows downhill, concern for watersheds has flowed uphill. As downstream beneficial uses and public works lose value due to individual and cumulative effects of watershed management, downstream users seek to gain information about, and authority over, upstream practices. Watershed assessment is a priority for landowners, regulators, and the public, all of whom make land management decisions.

Landowners and their representatives engage in land development, resource use, water conveyance, and sometimes wildlife management. These people are often directly responsible for the quality of the land, its animals, and its vegetation. They usually have strong economic constraints and goals, because they generally manage the land for a profit.

Individuals in regulating agencies may only control compliance, focusing on the negative aspects of others" actions. They are often required to follow lofty but unspecific agency goals focusing on a geographically diffuse resource; they frequently restrict actions (and profit) as agents of the public trust. Agencies frequently have both management and regulatory roles, with different sets of people in each role. Sometimes, the roles are combined in individuals. Individuals with combined roles have greater freedom to plan the elements of land management, but ultimately respond to a supervisor and to agency guidelines.

The public has a role in watershed assessment and, ultimately, in land management. They are the users of the "beneficial uses" derived from private and public lands. The public represents itself in special organizations such as water agencies, counties, or affinity groups that have concern but little direct authority over resource management. It is increasingly important that the public be included in resource management decisions, to maintain the beneficial uses and to represent themselves within watershed assessment, restoration, and regulation. Well-informed citizens increase the value of a watershed assessment due to the expertise they bring, the time and energy they provide, the definition they give to the inquiry, and the ease they may bring to implementation if they have been part of the process.

This document briefly discusses watershed processes and policy, focusing on the assessment link in the decision-making chain, at the cusp of policy and practice. Assessment should be considered a survey instrument, for environmental inventories and/or impact prediction. Watershed managers need to know about watershed assessments because they will either have to use or respond to them. Understanding how assessments work, what choices were made in the selection of a specific system, and what alternative approaches are available, should be useful to managers and regulators alike.

This document organizes representative assessment strategies. It assumes that managers are responsible for data collection and analysis, and are interested in the reasons why data must be collected, what physical and biological processes can be monitored at a watershed level, and how the data should be collected in order to be useful.

This report is written for all these people. Watershed assessment is the link between watershed law and the land. Because watersheds include all lands, watershed assessment techniques are valid, theoretically, in all places. Specific programs for watershed management and assessment are already in place in urban, rural, agricultural, range, and forest areas. Because watersheds are the physical, hydrologic link between the atmosphere, the soil, particular ecosystems, and the oceans, watershed assessment issues are important to all land and water managers and regulators.

Finally, this document is not meant to stand alone; greater detail is always necessary. Land managers and regulators must continue to use their own expertise, the specific codes and legislation that determine pollution levels and mandate best management practices, and the many references on water pollution and land assessment strategies. This document is designed as a signpost, to point readers to effective approaches for assessment of their own, unique watershed.

# 2. THE WATERSHED APPROACH

## 2.1. WATERSHEDS

Watersheds are drainage basins (Figure 1). They range from the smallest unit, the unchanneled "zero-order" basin, through to the largest drainages on the planet (Table 2). Watersheds may be broken down into smaller, contributing subwatersheds, or assessed as whole units. In many cases it is impractical to assess a complete basin. The Columbia River, for instance, drains over one hundred million acres. Smaller subwatersheds within the larger watershed or river basin are more useful planning units because they have greater homogeneity in land use, vegetation, ownership, and government authority. These subwatershed "planning units" or "assessment units" range from thousands to over a hundred thousand acres. In most cases these units are themselves watersheds, but may also be defined as a set of subwatersheds not including drainage areas upstream, downstream, or across the basin; in these instances, the planning units may follow subwatershed boundaries, but are not designed to be stand-alone assessment areas.

**Table 2. Number and Length of River Channels and Their Watersheds in the United States (excluding tributaries of smaller order).**

| Order[a] | Number | Average Length (miles) | Total Length (miles) | Mean Drainage Area, Including Tributaries (square miles) | Representative Watershed |
|---|---|---|---|---|---|
| 1 | 1,570,000 | 1 | 1,570,000 | 1 | |
| 2 | 350,000 | 2.3 | 810,000 | 4.7 | |
| 3 | 80,000 | 5.3 | 420,000 | 23 | |
| 4 | 18,000 | 12 | 220,000 | 109 | |
| 5 | 4,200 | 28 | 116,000 | 518 | Alsea |
| 6 | 950 | 64 | 61,000 | 2,460 | Umpqua |
| 7 | 200 | 147 | 30,000 | 11,700 | Yakima |
| 8 | 41 | 338 | 14,000 | 55,600 | Kuskokwim |
| 9 | 8 | 777 | 6,200 | 264,000 | Columbia |
| 10 | 1 | 1,800 | 1,800 | 1,250,000 | Mississippi |

[a] The definition is that of Strahler: Order 1 is a channel without tributaries; order 2 is a channel with only order 1 tributaries, but includes the length segment between the junction upstream of order 1 channels and the junction downstream with another order 2 channel. (Adapted from Leopold et al., 1964.)

Watershed assessment focuses on those elements that affect beneficial uses. Generally, the elements of beneficial uses are contained in the hydrologic, biologic, and topographic features of the watershed. These elements can characterize or determine water flow, sediment flow, vegetation change, wildlife habitat, and pollution sources (Figure 2). Assessments must also consider social factors of ownership and political boundaries. Together these elements give a picture of a watershed as a hydrologic unit and as an ecosystem with human influences.

Watersheds define flow paths for more than water; they are paths for nutrient cycling, vegetation changes, and geomorphic processes. Watersheds define the limits of aquatic habitats, and of the fish, reptiles, insects and other invertebrates endemic to those habitats. Watersheds collect and transmit rainfall with entrained atmospheric chemicals. And, when altered by human action, watersheds change their "natural" flow paths accordingly.

The characteristics of a watershed are determined by its geology and tectonic forces, climate and precipitation, biota, time, and unique history. The biotic components of the watershed, the plants and animals, are themselves dependent on the habitat created within the watershed. In addition to habitat, watersheds provide sources, paths, and boundaries for nutrient cycling intrinsic to the sustenance of plants and animals.

**Figure 1: Watershed**

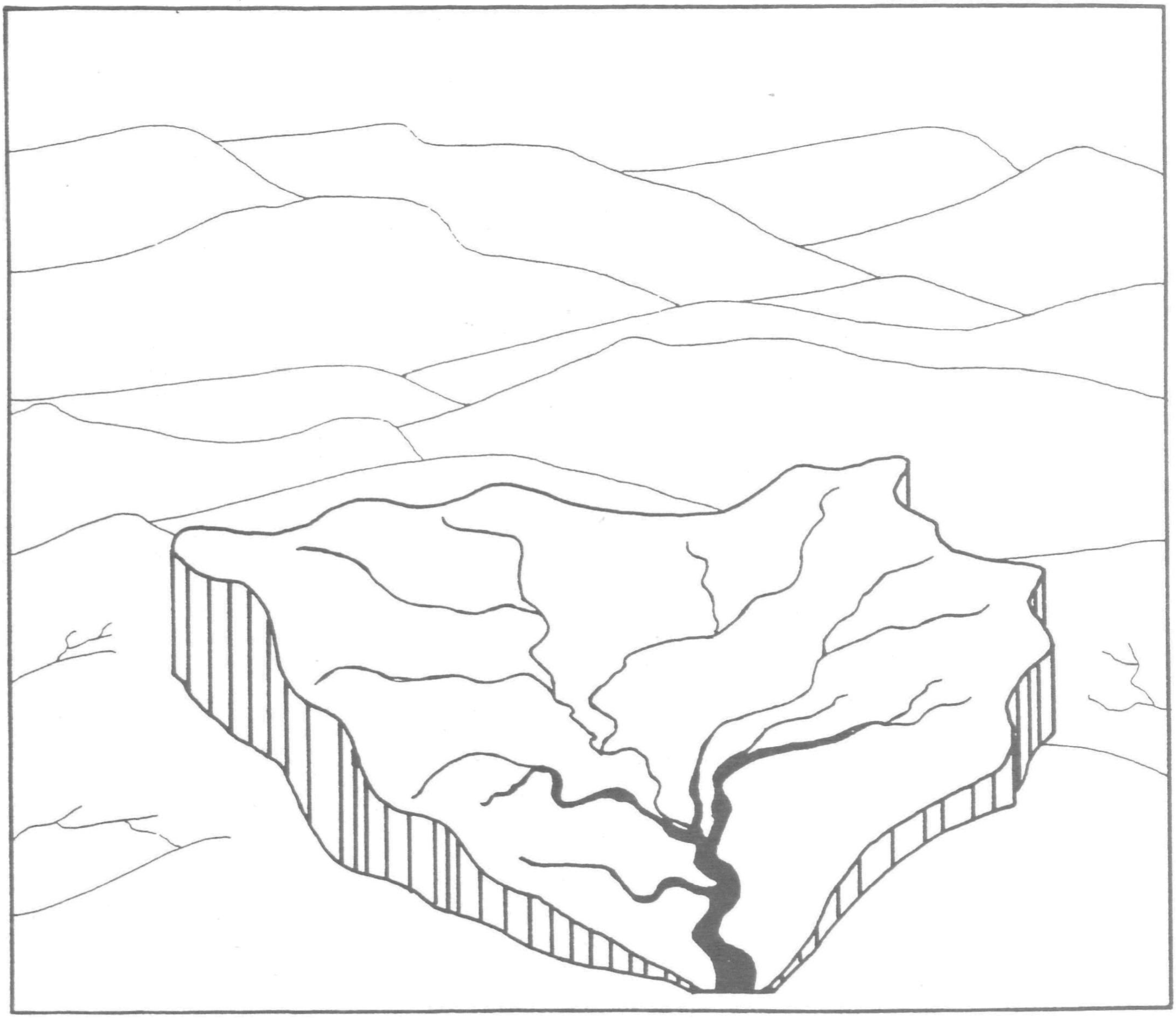
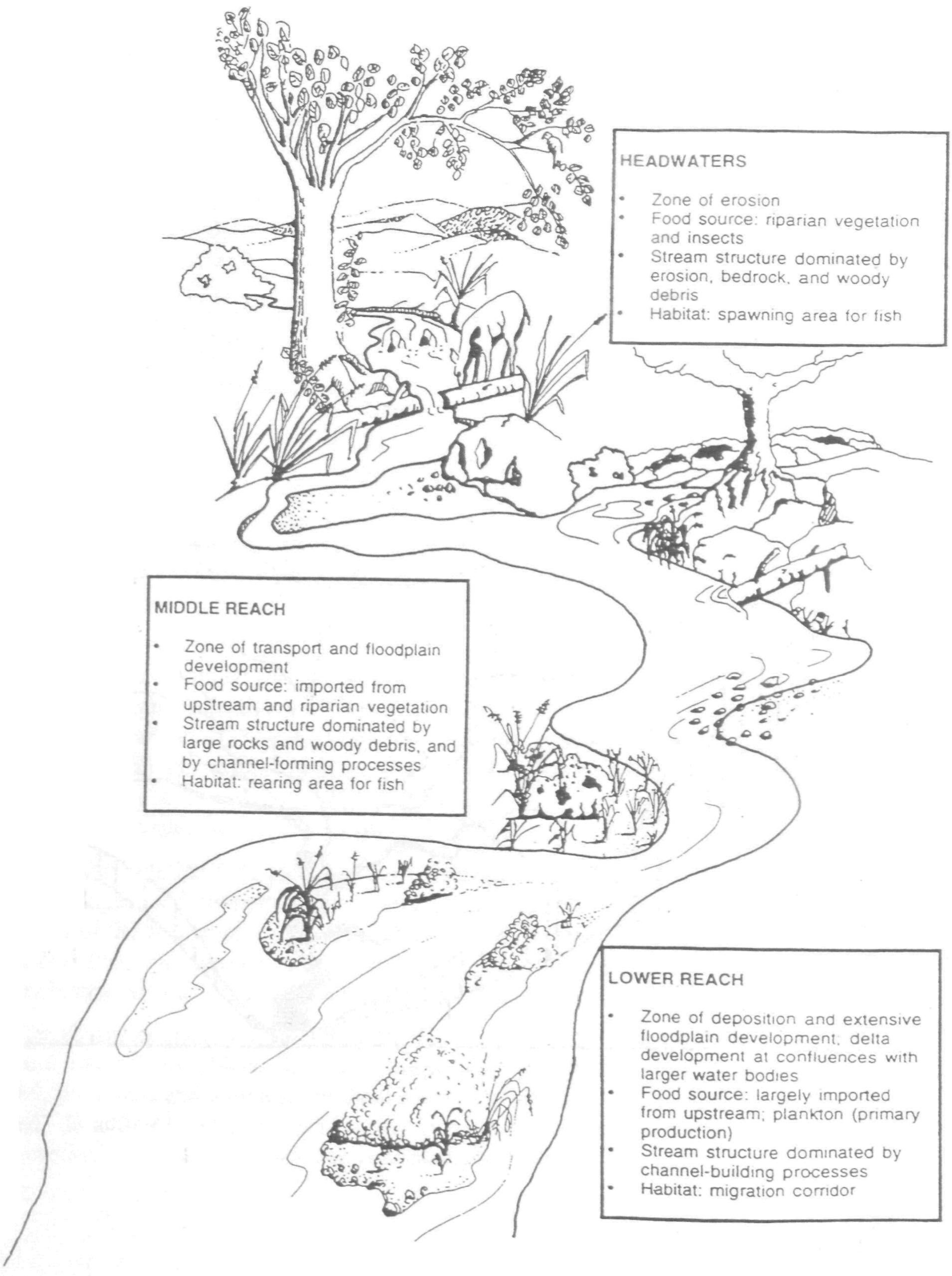


**Figure 2: Stream Characteristics for Watershed Analysis**



Humanity tends to perceive watersheds from a utilitarian perspective: range, forestry, urbanization, recreation, agriculture, water development, mineral extraction, or other human uses. Meanwhile, the watershed's characteristics also determine a level of physical, chemical, and biological functions. The functions that enable the watershed to adjust to natural and human disturbances give it resilience. In general, warmer climates, deeper soils, more precipitation and richer subsoil form a watershed with faster growth and more biotic activity, resulting in a relatively more resilient environment. But both human impacts and natural disturbances may alter the environment beyond the watershed functions" ability to reconstruct the environment over years, decades, or even millenia. The watershed will adjust to those impacts by creating a transitional environment.

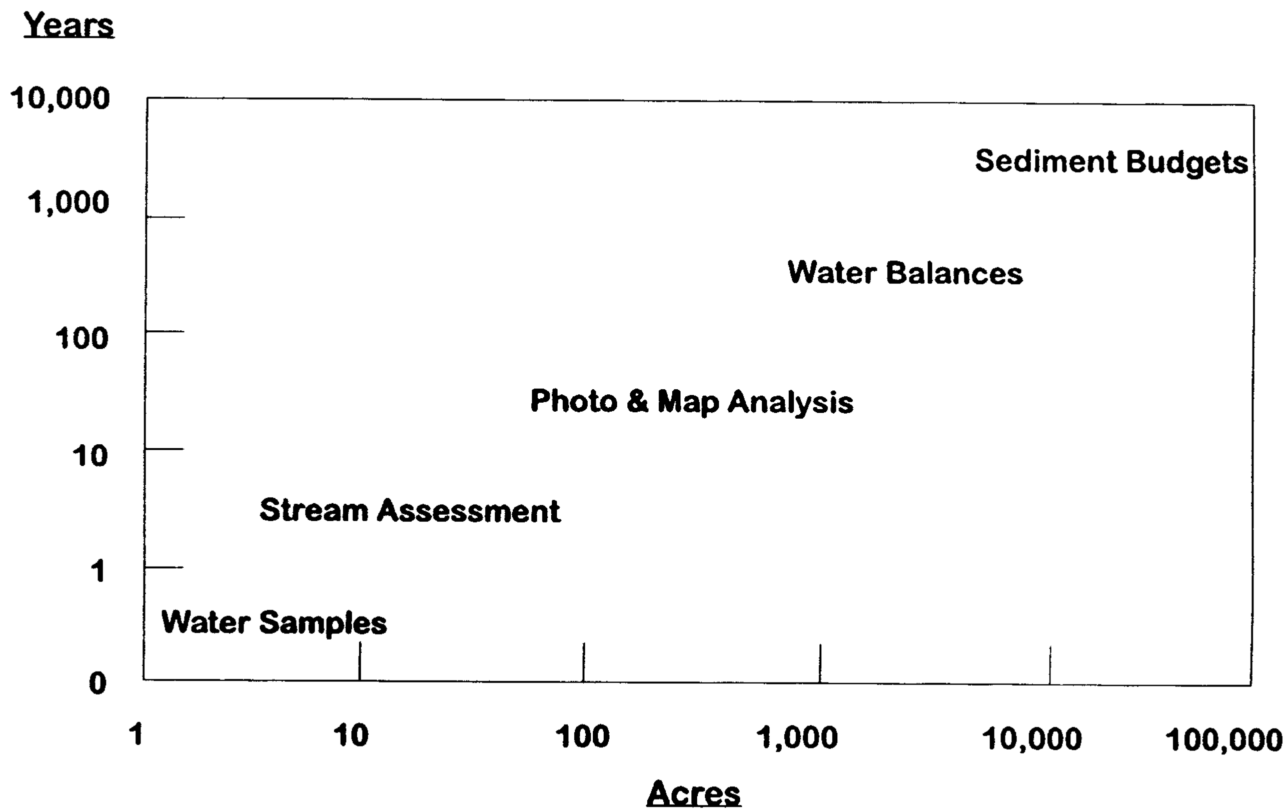
A "natural" set of transitional environments are responses to impacts from tree fall, landslides, fire, flood, drought, pests, diseases, volcanoes, meteors and the like. Human impacts on the same environments may be strikingly different, particularly over time, and create environments "not found in nature," or new to the watershed. Examples are roads, timber harvesting, introduced species, farming, and fire control. A new set of responses is engendered with each new impact, and the resulting environment may or may not be desirable for people and the other species that share the watershed. In each case, impacts elicit responses.

Responses to human versus natural impacts differ because watershed functions are adapted to respond to natural disturbances, not to human disturbances. While natural disturbances often lead to greater diversity in watersheds, human disturbances often simplify watershed drainage patterns or biodiversity. Similarly, "healthy" watersheds may recover from large scale, long-term natural disturbances more robustly than from human impacts of a similar scale. Because responses take place over a range of time scales, it is difficult to learn much from a single watershed condition assessment. Because impacts can result in cumulative effects, it may take many years for a watershed to effectively stabilize. Some forms of human impact such as severe erosion following mining may exceed the ability of a watershed to stabilize within human time scales.

Any analysis of watershed condition needs to assess the variability of watershed functions and characteristics over time and space. A stable or healthy watershed is not defined by a no-change condition, but includes varying species composition, erosion rates, and stream morphology that occur in response to disturbances. Natural communities are not absolutely stable over time. Environmental variability prevents consistent equilibrium (Wiens, 1977). Managers and watershed assessors should recognize that environmental changes, natural or human-induced, will always favor one suite of biota or beneficial uses over another — whether this is good or bad for the watershed may be a "judgment call," determined by the perspective of the observer.

In response to the range of variation in watershed functions, many different tools are available to assess watersheds. They range from point-in-time-point-in-space analyses, like water samples, to very-long-term-very-large-space approaches, like sediment budgets. Managers gain different knowledge from their application, and, in fact, are generally already using some tool which yield the daily knowledge they need. Timber stand surveys, wildlife transects, soil analyses, road maintenance checks, airphoto surveys, stream gauging, precipitation monitoring, and stream habitat surveys are all watershed analyses with implicit time and space scales. Figure 3 compares some of these approaches in their respective time and space frames.

**Figure 3: Time and Space Scales for Watershed Assessment**




## 2.2. Streams and Watercourses

A watershed's most apparent flow paths are shown by flowing streams and non-flowing watercourses. Together, these create the watershed's surface drainage pattern, or stream network. A stream network results from the erosion processes on the original landscape, reflecting the hardness of its rocks, faults and joints in the geology, and historical human and biologic processes on the landscape. Stream processes shape the watershed, creating alluvial flats, streamside erosion, and in-channel features.

Because streams concentrate flowing water, they also concentrate watershed pollutants. Pollutants that travel in solution or at the same rate as water may not concentrate over time. If, however, pollutants travel only at high flows, they may become stored within the stream system, stranded by previous flows, and awaiting sufficient transport velocities in the future. Sediment accumulation, for instance, is extremely flow-dependent.

Streams are also important habitat elements within watersheds. Gravity moves soil and vegetation into the stream channel providing both food and habitat for aquatic species. A particularly important element of the stream habitat is woody vegetation; the leaves are food for stream species, the living vegetation furnishes cover, and the large downed wood provides in-stream structure for habitat, food, sediment trapping, and bank protection.

## 2.3. Beneficial Uses

As locations for all land use activities, watersheds are also the sites for all beneficial land uses. Water is used for domestic, agricultural, and industrial supply, for recreation, power generation, and in-stream uses such as navigation and the maintenance of habitats. Outside the stream channel, watersheds are used for forest or agricultural production, recreation, greenbelts, sediment trapping, noise reduction, mining, grazing, urban development, and wildlife habitat. Beneficial uses are defined by human use.

Beneficial uses are those which may be justified as having a value, either as a public trust or as property. Hildreth et al. in the Appendix to this report, note the legal standing of "target resources," specifically mentioning Native American subsistence rights and stating that it is reasonable that standing may be expanded to include wildlife species and species diversity, watersheds, recreational use, soil retention, and water quality.

In California, the Porter-Cologne Water Quality Control Act gives the State Water Resources Control Board "[A]uthority... to protect public trust uses and prevent waste, unreasonable use, [and] unreasonable methods of use... of said water." Beneficial uses which are specifically protected in the Act are "...domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves."

When a beneficial use, or the ability of a user to receive a continued beneficial use, is degraded, an impact has occurred. This may be an individual or a cumulative impact. If the degradation makes the use no longer possible at some level, that impact becomes a "significant adverse effect." It is important for watershed assessment strategies to identify beneficial uses, both present and potential, so that future impacts may be meaningfully assessed.

## 2.4. Impacts

Under the National Environmental Policy Act of 1969 (NEPA), Congress mandated that the Federal government review the environmental impact of proposed projects. NEPA uses the terms *impacts* and *effects* interchangeably, but we will distinguish them: *impacts* are the actions which cause *effects*. NEPA identifies *project* as an action, or a set of actions, which produce a suite of environmental impacts. Impacts may or may not have effects which are considered significant. Impacts may be on-site or off-site. Some impacts may affect long-term site productivity. Some impacts may cause "irreversible or irretrievable commitments of resources," or an unrecoverable loss of beneficial use.

*Cumulative impacts* are defined in NEPA as the effects of several projects over time, from the past into the foreseeable future. An undesirable effect, by this definition, restricts project developers from putting forth a series of incremental projects for individual review, while avoiding responsibility for the impacts of the completed series. The nature of watersheds, to receive and concentrate water from a large area, implies that both in law and in fact, they will receive and concentrate water-borne or gravity-driven cumulative effects. The expressions of impacts at the watershed level in terms of sedimentation, flow, organic debris, or other channel characteristics are termed *cumulative watershed effects* (CWE's). Williamson and Hamilton (1987) have prepared an annotated bibliography of the earlier literature.

## 2.5. Assessment and Control of Water Pollution

Pollution can be defined as a resource in the wrong place at the wrong time. In practice, water pollution is a broad spectrum of conditions that limit the ability of water to provide beneficial uses. Organic and inorganic materials are "typical" pollutants that can be measured within a sample of water. Less easily quantified are changes in the condition of streams, such as increased heat, reduced flows, increased peak flows, or accelerated natural erosion. Harder still to address are species changes due to introduced exotics, habitat changes due to built structures, or reduced species use of habitat due to external conditions. While these last changes are not strictly pollution, they do reflect a change in the nutrient cycles of the watershed and a reduction in beneficial uses.

Alaskan law gives a good general definition of pollution, linking it to resources and recognizing a continuity between surface water, land, and subsurface water. The inclusion of aquatic insects as wildlife and altered flow as pollution extends the sense of this language to include a broad spectrum of watershed resources. The Alaskan statute reads:

> Pollution means the contamination or altering of waters, land or subsurface land of the state in a manner which creates a nuisance or makes waters, land or subsurface land unclean, or noxious, or impure, or unfit so that they are actually or potentially harmful or detrimental or injurious to public health, safety or welfare, to domestic, commercial, industrial, or recreational use, or to livestock, wild animals, bird, fish, or other aquatic life (Alaska Stat. sec. 46.03.900).

Watershed assessments are part of a response to the Water Quality Act Amendments of 1987, which highlighted the need to control, "in an expeditious manner," both point and non-point sources of pollution. Point sources are traced to a single "pipe" or single source, and have traditionally been the target of water quality agencies. Point sources are typically controlled through prescription and water quality standards, leaving the choice of specific mitigation method to the producer.

Non-point source (NPS) pollutants originate with an action or set of actions that produce pollutants over a wide area. Typical non-point pollutants are oil and grease from urban runoff, fertilizers and pesticides from farm runoff, or sediment and elevated water temperatures from forestry activities. Reduction in NPS pollution is normally achieved through prescription, with the resource user installing on-the-ground "best management practices" (BMPs).

## 2.6. SIGNIFICANT ADVERSE IMPACT

Because many processes that degrade watersheds cannot easily be defined as pollution and because NEPA is intended to address significant environmental impacts within Federal jurisdictions, it is important to define *significant impact* within the context of relevant statutes and authority. The Council on Environmental Quality (CEQ) uses "significant" as a threshold for the application of cumulative effects analysis. "...Cumulative impacts can result from individually minor but collectively *significant* projects taking place over a period of time" (40 C.F.R. 1508.7 and 1508.27).

Greater specificity is shown in the California Environmental Quality Act of 1970 (CEQA). The regulations define "significant adverse impact on the environment" as:

> A substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic and aesthetic significance. An economic or social change by itself shall not be considered a significant effect on the environment. A social or economic change related to a physical change may be considered in determining whether the change is significant (California Administrative Code. Title 14, Div. 6, Art. 20, sec. 15382).

CEQA guidelines for "impacts normally deemed significant" address streams, watersheds, and water quality and define impacts as those activities that will have a substantial, demonstrable negative aesthetic effect, interfere substantially with the movement of any resident or migratory fish or wildlife species, substantially degrade water quality, contaminate a public water supply, cause substantial flooding, erosion, or siltation, expose people or structures to major geologic hazards, or substantially diminish habitat for fish, wildlife, or plants (Remy et al., 1990). These guidelines demonstrate a hierarchy of significant adverse impact, and by extension, cumulative effects. The most localized changes are the specific deterioration of water quality, scaling up to broad effects such as the extinction of a species.

In order to determine the environmental health of a watershed under a variety of impacts, certain concepts have been articulated to describe the elements of watershed change. These concepts include the threshold of concern, ecosystem integrity, and habitat condition.

### *2.6.1. Threshold of Concern*

In some physical and biological contexts, there are thresholds which, when crossed, change the nature of the system. An example of such a threshold is a population dropping below the recovery level. Similar thresholds exist in watersheds — a stream affected by intense management and flooding can abruptly widen and aggrade its channel, or over-nutrification of a lake may cause an algal bloom and subsequent die-off. Natural systems may possess buffers to minor fluctuations but may not have the resilience to recover from major changes.

This concept of resilience has been incorporated in some models of cumulative impacts. Key indicators might be used to alert managers to possible thresholds beyond which cumulative impacts become significant. Some cumulative impacts appear to have a threshold beyond which very large changes can occur. A threshold value can be fraught with uncertainty because impacts are cumulative, and frequently unquantified, and the key indicators are site specific. In addition, environmental changes are often gradual, instead of catastrophic.

Frissell (1992) argues that thresholds can be misused by land managers. By assuming that natural systems have buffers, managers can affect those systems within an uncertain or somewhat arbitrary tolerance level. Such tolerance levels rarely leave an adequate margin for cumulative effects, "acts of God," or error. The possibility that a landslide might occur from a particular timber harvest can only be generally predicted by evaluating potential landslide factors and estimating the likelihood of failure. As Rice states, "The manager must decide what is an 'acceptable risk' of causing a slide by logging" (Rice et al., 1984).

### *2.6.2. Ecosystem Integrity*

The 1972 Clean Water Act (CWA) has the objective "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (§ 101). This inclusion of biological integrity suggests application at many levels, from individual species up to the watershed. The term "ecosystem integrity" refers to a broad concept used to indicate watershed and stream "health." Karr et al. (1986) list the factors affecting ecosystem or biotic integrity: energy sources, water quality, habitat structure or quality, hydrology or flow regime, and biotic interactions. Karr and Dudley (1981) define ecosystem integrity as:

> The capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region....A system protecting integrity can withstand, and recover from most perturbations imposed by natural environmental processes, as well as many major disruptions induced by humans.

The most effective approach to restoring and maintaining resources may be to protect ecosystem integrity. Levin and Kimball (1984) state:

> The health and integrity of the ecosystem must be the ultimate concern of environmental regulation. If its basic functions are threatened, all species in that ecosystem are threatened. Individual species may be lost and lamented, but most are replaceable from the viewpoint of ecosystem function. However, if the overall productivity of the system is affected, or its capacity to maintain the flow of energy or the cycling of chemical elements necessary for life, the consequences may be catastrophic.
>
> Halting chemical degradation of water does not ensure the restoration of ecological or biotic integrity. The ability of a water system to sustain a balanced biological community is the best indicator of its health, yet that ability is largely unprotected by present monitoring and assessment techniques (Karr et al., 1986).

Rowe (1992) contends that species can take care of themselves if the ecosystems remain intact. Lee and Gosselink (1988) broaden this concept to promote a landscape approach, which can include adjacent interacting ecosystems. They suggest that a landscape approach can conserve the valued functions and biota of smaller subsystems.

Definitive measures of ecosystem integrity are hard to find. Researchers use a variety of methods that incorporate some of the following characteristics: they measure an essential component of ecosystem integrity; they reflect social or public values of the resource; and they attempt to use indicators that are measurable and credible within financial, temporal, and technical constraints.

### *2.6.3. Habitat Condition*

Habitat is a determinant of an ecosystem's health and stability. Habitat can be a limiting factor in determining the abundance, diversity, and survival ability of the biological community. The habitat itself must be diverse. For fish, different habitats are required for rearing young, as refugia from predatory species and adverse environmental conditions, and as migration corridors. Habitat structure necessary for salmonids includes gravels for spawning, pools for rearing, cool water high in dissolved oxygen, and adequate inputs of riparian biomass to maintain an aquatic insect population. Downed logs, leaves, flying insects and eroding soil all form the stream and fishery habitat.

Many current and past land use practices had adverse effects on the stream environment, reducing the present and potential structure. In the 1960's and 1970's, streams were "cleaned" of woody debris to allow better fish passage, greatly reducing habitat elements. Similarly, logging or clearing in riparian zones reduces future debris necessary for structure and food. Sediment settles in pools, reducing space for fish and potentially increasing average stream temperatures. Sediment also reduces the area of available spawning gravels and can affect the overall survival of young fish.

Without essential habitat structure, many forms of aquatic life are eliminated from streams. Thus, non-point control efforts that produce high water quality (physical/chemical conditions) may fail to produce a water source with high biotic integrity if suitable physical habitats are absent (Karr and Dudley, 1981).

## 2.7. Critical Non-point Sources of Pollution

Watershed assessment is of greatest value when it identifies site-specific remedies for a watershed, improving beneficial uses in a cost effective manner. Similarly, assessing cumulative effects of watershed impacts is most meaningful when specific sources of degradation are tied to specific impacts within a specific frame of time and space. Because non-point pollution sources may be derived both from large areas and from small, discrete zones of impact, an important consideration in determining cause and effect is determining the source of impact. The answer is not trivial, because the remedies for wide-scale small impacts are very different from localized, intense impacts.

The general approach to reducing the non-point pollution has been Best Management Practices (BMPs), which are to reduce incremental amounts of pollution over a very large area. BMPs tend to be situational prescriptions, and range from purely voluntary to mandatory, depending on the physical and institutional setting of activities. Critical areas require site specific prescriptions to staunch the flow of non-point pollution, but many be outside the normal implementation of the water quality regulatory process. Thus, critical areas can be contributing to cumulative impacts and reducing beneficial uses, but not be singled out for special assessment or remediation. This imbalance leads logically to the propagation of cumulative effects and the continued reduction of beneficial uses within the frame of "standard practices."

Critical non-point sources may result from natural instabilities, human impacts, or a combination of the two. Landslides in unstable terrain, for instance, generate extensive amounts of sediment but are often beyond remediation. Critical non-point sources of sediment from human activities are roads that fail, large sediment deposits in stream courses that fail over time, and runoff from dairies and feedlots, from eutrophic ponds that "spill over" into streams, or seepage from aggregations of septic systems. Some elements of present management remain as critical sources affecting ecosystem integrity, for example riparian zone modification, sediments and chemicals from farm land and road runoff.

Watershed assessments should key first on easily identifiable point and non-point sources as determined by maps and airphotos. On-the-ground analysis will test the initial findings through physical measures of the impact. Tributaries bearing volumes of sediment will have depositional features and turbidity unlike other tributaries; high nutrient loads may be identified through algal blooms and water samples. Undoing old practices, repairing scars from accidents, identifying natural and other exceptional sites will be a useful outcome of watershed assessment. Site-specific remediation of critical non-point sources will potentially reduce cumulative effects and allow the watershed to better assimilate other non-point sources.

### 2.8. Risk Analysis

Many of the processes that need to be described in watershed assessments are probabilistic events. Because of the level of unpredictability (weather, future activities, etc.) and uncertainty (impact pathways, magnitude of impacts, etc.), the best assessment of potential impact from cumulative effects will be in the form of a risk assessment.

Uncertainty arises from our conceptualization (models) of how ecosystems function, from the stochastic nature (unpredictability) of natural events, and from measurement errors (Suter et al., 1987). Through computation of the magnitude of uncertainty in different components of the analysis, a risk assessment expresses uncertainty as the probability of occurrence of an undesired event (Hunsaker et al., 1990).

Risk assessment is increasingly being used in water resources management and non-point source pollution control. Since absolute predictions regarding impacts from the cumulative effects of a wide variety of actions are beyond our capabilities, the relative predictions provided by a risk assessment may be the most reliable decision-making tool at this time. "Risk analysis can provide a more rational basis for decisions that may otherwise be highly subjective, by (a) emphasizing probabilities and frequencies of events and (b) explicitly quantifying uncertainty" (Suter et al., 1987).

## 3. WATER QUALITY IMPACTS FROM SELECTED LAND USES

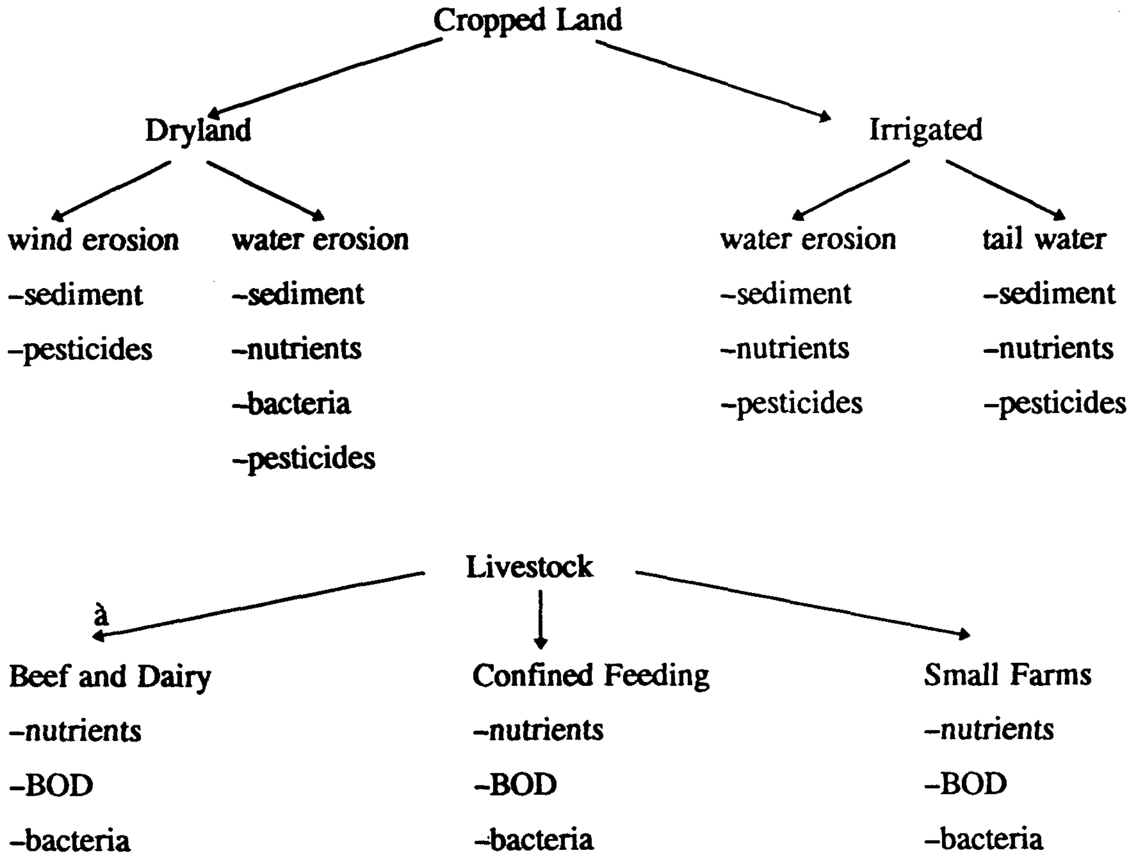
A current emphasis in water quality protection is control of non-point sources of pollutants that arise from land-water interaction. Non-point source impacts vary with land uses, and practices for satisfactory protection of water quality are often specific to those land uses.

MacDonald et al. (1991) present a good summary of the influence of forest land uses on water quality. The considerable literature on water quality impacts of crop and livestock agriculture is summarized in section 3.1. Less information has been collected and evaluated for grazing lands, mining, and urban land uses. This chapter presents information on these uses.

### 3.1. Crop and Livestock Agriculture

#### *3.1.1. Sources*

Land used for crop production and for raising livestock is a major source of non-point pollution to surface waters and to groundwater. Land under cultivation has an exposed surface without protection of vegetative cover for at least part of a year. Five major sources of non-point pollution are water and wind eroded sediments from tillage of dryland, water eroded sediments and nutrients from irrigated land, nutrients lost from systems of production for high value crops, pesticides and other chemicals used in crop production, and manure from animal production.




Soil erosion rates from winter rainfall in the Pacific Northwest can be high. Soil loss of 25 tons per acre is not uncommon; even with modest delivery ratios, this delivers a large volume of sediment to streams (Busacca et al., 1993). Erosion from furrow irrigation can be considerably higher.

Large inputs of fertilizer and pest-control chemicals are used on high-value crops. For example, row crops can receive applications up to 350 pounds of nitrogen per acre per year, only about half of which is removed in the crop. Livestock produce large amounts of manure, with a high biological oxygen demand (BOD) for decomposition, a high content of bacteria, a high content of nutrients and a high content of some salts. For example, a cow produces 11 tons of manure per year. A typical manure application of 25 tons per acre of cattle manure can contain 250 lbs of N and 35 lbs of P. A 10-ton application of chicken manure can contain 400 lbs of N and 200 lbs of P.

While the total area in small farms ("hobby farms" of 5 to 10 acres) is not large, the per acre non-point pollution often exceeds that from large, commercial farms (Godwin, 1994). Inputs of fertilizer and chemicals are not as closely controlled by economics, stocking rates of livestock often exceed the capacity of the land to decompose the manure, and the animals often have direct access to small streams.

Confined Animal Feeding Operations (CAFOs) are usually considered as point sources, so their discharge would be subject to permits. Dairy farms are installing waste handling facilities to store manure during periods when application to the land is not feasible, for example, during winter months in the Northwest. The number of dairy cows often exceeds the capacity of the land; the crops grown cannot use all the nutrients in the manure. This is a major source of nitrate in groundwater. Cattle feeding operations generate large amounts of manure in a limited area, leading to high loading of nitrates.

The use of cropped land for waste disposal can lead to pollution. Sludge from sewage treatment plants is routinely applied to soils, often at rates that exceed crop requirements for nitrogen (Elliott, 1986). The rate of release of nitrogen during decomposition of the organic sludge depends upon temperature and moisture conditions in the soil. The amount of nitrogen available from sludge in the spring is, therefore, uncertain, which leads many farmers to also apply commercial fertilizer at usual rates. This leads to a large excess of nitrogen, which can leach to groundwater. Additionally, sewage sludge contains varying concentrations of heavy metals such as lead, copper, and zinc. The capacity of land to accept sludge from facilities which mix industrial and domestic wastes is limited.

### *3.1.2. Compliance*

Control of soil erosion has been an issue of agricultural policy since the dust storms of 60 years ago. The Soil Conservation Service (SCS) was set up to provide technical assistance, the Soil and Water Conservation District (SWCD) provide the local organization and the Agricultural Stabilization and Conservation Service (ASCS) administers federal cost-share dollars for conservation practices. The resurgence in the 1970s and 1980s of federal programs to prevent soil erosion had as much to do with maintaining farm income as with saving soil. Erosion control has now been replaced as the main concern by water quality from non-point sources (for example, the 1990 Farm Bill). Recent concepts of watershed or ecosystem management, if implemented, would be very effective in control of erosion. Erosion control is not something that can be solved once and then forgotten; it must be an integral part of every crop production system.

The USDA (USDA, 1989; USDA-SCS, 1990) has a coordinated program of technical assistance, demonstration and cost-sharing to decrease non-point pollution through initiatives such as the 90 Hydrologic Unit Areas and 15 Demonstration Projects for impaired watersheds. The problem has been to achieve the cooperation required for successful implementation. Other USDA activities include the Small Watershed and Flood Prevention Program to decrease loading of sediment and chemicals to streams, a Crop Residue Management Action Plan to provide information for erosion control on highly erodible land, and cooperation with other agencies in the Salmon Initiative in the Northwest. The SCS Field Office Technical Guide is the source for information on conservation technology.

An earlier program was the USDA (ASCS in consultation with EPA) Rural Clean Water Program, initiated in 1980 for ten years, to address agricultural non-point source pollution on a watershed scale (Gale et al., 1993). Best management practices were implemented on 21 watersheds, and effects on water quality were monitored. Landowner participation was voluntary.

There is little good information on how effective the incentives and cost-sharing of BMPs have been in erosion control (Zinn, 1993). There is evidence that they are imperfect because they reach only a part of the landowners. Studies based on questionnaires show that when asked if erosion is a problem, most farmers will agree, but when asked if erosion is a problem on their farm, they disagree (Steiner, 1990).

### 3.2. GRAZING LANDS

Management of cumulative effects from rangelands must address both the indirect effects that occur on the uplands and direct water quality impacts that occur in the stream-side zone. The typical grazed landscape in the West consists of narrow riparian zones surrounded by vast arid uplands. The conflicts between grazing and water quality converge at the riparian zone where the results of poor management on the uplands (erosion, sedimentation, water quantity) combine with direct impacts to the riparian zone (stream banks and riparian vegetation).

The impacts on water quality arise from the combined effects of altered watershed function and direct impacts to the stream and riparian zone from livestock use (Kauffman and Krueger, 1984; Clary and Webster, 1990). Livestock are attracted to riparian areas because of succulent forage, easy accessibility, shade, and a reliable water supply (Skovlin, 1984). A watershed has three primary hydrologic functions that are modified by overgrazing (Bedell, ed., 1991): 1) capturing precipitation where it falls, 2) storing water in the soil profile, and 3) safely releasing water as subsurface flows in springs and seeps or into groundwater. Water infiltration rates (capture of water) are influenced by plant cover that reduces raindrop impact on the soil, plant litter and organic matter that absorb moisture, and plant cover that traps snow near the soil surface. Water stored in the soil profile is released slowly to the water table to maintain the riparian zone and to increase summer stream flows. Reduction or elimination of vegetation alters watershed function and promotes surface runoff. Increased runoff increases upland sheet and rill erosion resulting in stream sedimentation. Increased peak runoff also increases stream energy for bank erosion, downcutting, and gully formation. Decreases in water infiltration and storage reduce low summer flows critical to water quality, fisheries, and wildlife.

Grazing has potentially detrimental effects on the water column, stream banks, stream channel, and riparian vegetation (Platts, 1991; Elmore and Beschta, 1987). Heavy grazing and trampling affect stream habitats by reducing or eliminating riparian vegetation, changing streambank and channel morphology, and increasing stream sediment transport (Clary and Webster, 1990). Sediment, fecal bacteria, and nutrients may also increase in grazed watersheds. Overgrazing causes a shift from willow and sedge plant communities, which protect stream banks, to shallow-rooted grasses and forbs. Stream channels in overgrazed riparian zones become wider and shallower and have fewer bank undercuts. Overhanging vegetation is reduced and stream temperatures increase due to the decreased shade. Increased temperature due to reduced streamside vegetation may be responsible for the gradual shift from salmonids to non-game fish in many Western streams (Platts 1991). All these alterations decrease the habitat available to support fisheries and other aquatic life.

The process of assessing watershed health and water quality effects in rangeland is organized into three major steps: 1) classification and stratification, 2) inventory, and 3) monitoring. Classification organizes the landscape into similar units for inventory, monitoring, and management. Inventory provides a basic description of the stream and range condition using rapid qualitative methods. Monitoring uses quantitative methods to detect changes in water quality over time.

### *3.2.1. Classification of Grazing Lands*

Most classification procedures utilize a hierarchical system to organize similar landscape units, for example, vegetative type, climatic zone, and plant association. Classification is based on identifying the climax community or "potential natural community" which should occur on the site in the absence of impacts. The BLM and SCS utilize the Standard Ecological Site Description procedure (USDA-SCS, 1976; USDI-BLM, 1990), which has been recently updated for application to riparian-wetland sites (Leonard et al., 1992).

Riparian classification systems identify units based on riparian community types, a dominant overstory species and the most characteristic undergrowth species (Padgett et al., 1989). These community types are the vegetative expression of soils, climate, hydrology, and landform characteristics. A BLM work group reviewed eleven riparian classification systems that are currently in use and provided a description to cross walk these systems (Gebhardt et al., 1990).

A stream classification system (Rosgen, 1993) based on geomorphology has become widely accepted as a logical means to stratify and catalog stream types. Stream types are identified on the basis of entrenchment, width/depth ratio, sinuosity, channel materials, and slope. The stream type system provides a framework to establish objectives and management prescriptions based on site-specific characteristics.

### *3.2.2. Inventory*

The procedures adopted by BLM and SCS serve as an example of watershed inventory methods for rangelands. In 1982, BLM adopted the Range Site Inventory procedure described in the SCS National Range Handbook (USDA-SCS, 1976). An interdisciplinary team collects data on soils, climate, hydrology, and vegetation to develop the ecological site description (Leonard et al., 1992). The site description provides the basis for evaluating site potential. This information can be used to extrapolate monitoring information and provide analyses for management decisions.

Inventory and monitoring procedures have been developed separately for riparian areas because of the unique interactions between the water environment and streamside soils and vegetation. Examples of riparian inventory and monitoring procedures are described by Meyers (1989) for the BLM and in the Integrated Riparian Evaluation Guide (USDA Forest Service, 1992) for the Intermountain Region of the Forest Service. These methods evaluate the potential riparian plant community type and selected characteristics of the aquatic resource, such as bank stability and substrate composition.

### *3.2.3. Monitoring—Uplands*

Monitoring methods are an extension of inventory procedures, but are quantitative and resource intensive. Three basic approaches are utilized to monitor upland resources: soil and water relationships, vegetation, and methods that evaluate the soil resource itself (Bedell and Buckhouse, 1994).

Soil and Water Relationships address the watershed objective of producing well-functioning quantity, quality, and timing of water flows. Infiltration of water into the soil profile is a critical measure. Infiltration plots on micro-watersheds measure surface runoff and subsurface percolation from actual or simulated rainfall events. Infiltration can also be measured using lysimeters or ring or bucket infiltrometers.

Vegetative Measures address the function of vegetation in capturing precipitation and influencing soil infiltration. Managing vegetation is the primary tool used by land managers and livestock operators to improve watershed health; hence, vegetative measures have received the most attention. Range managers have developed a number of approaches to quantify soil and vegetative characteristics, such as pace and line transects and point frames. Important site parameters include: percent bare soil, plant canopy cover, plant basal cover, plant density, plant weight, plant frequency, species composition, species utilization, and residual vegetation (Bedell and Buckhouse, 1994). Methods to measure these parameters are described in range manuals such as Range Research: Basic Problems and Techniques (Cook and Stubbendieck, 1986) or agency procedures manuals.

Soil Characteristics at a site bear directly on the site's capacity for water infiltration. These characteristics include soil movement, surface rock and/or litter, pedestalling, flow patterns, and rill and gully formation (Bedell and Buckhouse, 1994). A periodic description of the characteristics can be useful in assessing the site's capability to capture and store water.

### *3.2.4. Monitoring—Riparian Areas and Water Quality*

In this report "riparian area" is defined to include the water column, the stream channel, the stream banks, and the wetted soils on which characteristic riparian vegetation grows. Cause and effect analysis should target the limiting factors for existing and desired beneficial uses in the waterbody. In the western United States, cold water biota, for example, salmonid species, are often the most sensitive beneficial use; therefore, the assessment should address their water quality and habitat needs. Other beneficial uses of concern are recreational uses and domestic water supplies, which are impacted by nutrient enrichment and pathogenic bacteria from livestock waste.

Water column characteristics that may be evaluated include temperature, shade, nutrients, fecal contamination, and flow modifications. Bank stability, bank undercut, overhanging vegetation, channel morphology, pool quality, and substrate sedimentation can be measured to assess impacts on stream bank stability and associated habitat values. The diversity and health of the streambank vegetation is assessed using standard vegetative measurement techniques. "Greenline" community composition is assessed by cataloging the riparian community types associated with the streambank. Woody species health is evaluated by classifying the percent of plants in each age class, for example, sprout, mature, decadent, dead. Utilization of forage within the riparian zone is measured to provide relationships to livestock grazing. Typical methods to assess riparian condition and fisheries habitat have been described by Platts et al., (1987) and Meyers, (1989). Bauer and Burton (1993) recently reviewed monitoring procedures for assessing impacts of grazing and recommended ten protocols which address changes to water quality, stream banks, and riparian vegetation.

The BLM has recently completed a method to assess Proper Functioning Condition in riparian areas (Prichard ed., 1993). The concept is to achieve an advanced ecological status, except where resource management objectives would require an earlier succession stage. Attributes of hydrogeomorphology, vegetation, erosion/deposition, soil, and water quality are described for the existing situation (State A) as well as for the watershed in properly functioning condition (State B).

Another approach under consideration is a procedure called Integrated Watershed/Landscape Analysis: An Ecosystem Approach (Janes, personal communication, 1993). This approach would evaluate physical and biological properties of the upland and riparian zone for an integrated model. Watershed condition could then be grouped into categories based on watershed condition and vulnerability to disturbance.

Some new methods for assessing rangeland health have been published by the National Academy of Sciences (NAS) (Committee on Rangeland Classification, 1994). The NAS approach classifies rangelands into categories of healthy, at-risk, or unhealthy, in order to identify the need for changes in range management. The report utilizes a Site Conservation Rating that can be used to compare with a threshold for recovery and to develop management objectives based on the "desired plant community." These methods are land-health based and would need to incorporate the special water quality functions of riparian areas in order to provide a holistic approach to watershed assessment.

### *3.2.5. Implications for Grazing Management*

Successful management of cumulative effects on rangeland will address both the needs of the livestock operator for year-round forage and the legal requirements for healthy watersheds and restored water quality required by the Clean Water Act. Grazing management strategies have traditionally prescribed distribution of livestock over time (seasons) and space (pastures) based on average forage conditions in the allotment. Grazing strategies such as rest-rotation and deferred methods are prescribed on the basis of maintaining vegetative vigor. This approach has generally failed to protect water quality because livestock graze riparian areas more heavily than adjacent upland ranges.

The continuing impacts of grazing on riparian areas have lead several authors to evaluate the compatibility of traditional grazing strategies with riparian values and function (Platts, 1989; Kovalchic and Elmore, 1992). Riparian areas will be overgrazed with passive, continuous grazing (season-long), and under programs of deferred rotation or rest-rotation grazing (Kinch, 1989). These evaluations consistently find that grazing use levels are one of the most important factors in designing grazing strategies that protect riparian values.

The Coordinated Resource Management Planning (CRMP) process has been used as a conflict resolution tool to involve the owners, managers, and resource users as a team to develop a resource management plan for an area. This approach provides a way to address economic, social, and technical issues within an organized planning framework (Anderson and Baum, 1987; Anderson, 1991).

## 3.3. Mining

Mining the vast mineral resources of the western states has played an important role in shaping settlement, and has left its mark on the landscape. Surface mining can be placer mining, which includes sluicing, panning, and dredging, or open-pit mining. Underground mining removes ore from a system of tunnels and shafts. Beneficiation of minerals is done by physical and chemical processes.

The U.S. Mining Laws Act of 1872 granted land-use priority to mineral extraction on all public lands not specifically withdrawn from mineral extraction. As a result, some 300 million hectares, or 68 percent of all public lands, are open to mining (Sheridan, 1977). Localized impacts of mining tend to re-occur as historic mining districts are continually re-evaluated and re-developed. Extraction and beneficiation of minerals generates 1-2 billion tons of mine waste per year. Most of the waste is from phosphate, copper, iron ore and uranium mining (U.S. EPA, 1986).

Historical mining activities have eliminated stocks of fish from entire drainages, for example, anadromous runs of steelhead and salmon in Panther Creek, a tributary of the Salmon River in Idaho. Abandoned mines may present long-term water pollution hazards, which are not uniformly regulated. These mined areas may contribute significantly to cumulative watershed impacts that must be addressed in watershed assessment.

Surface mining alters the landscape by removing vegetation and organic topsoil, thereby exposing large areas of land surface to erosion. Non-alluvial deposits are extracted by strip and open-pit mining. Both operations disturb aquatic habitats if they block or redirect surface flows, accelerate sediment delivery to streams and lakes, accelerate metals mobilization, or disrupt groundwater flows. Cyanide heap leaching is a form of open-pit mining that chemically extracts gold and silver from large quantities of low-grade ores. Heap leaching is often used to re-work historical tailings, and thereby continues the disturbance in a drainage basin over time.

Extraction of deposits by placer mining requires direct disturbance of streams and streamside areas. Historically, hydraulic mining used water under high pressure to remove ore from alluvial gravels, hence such mining drastically altered the land surface and carried large quantities of sediment into streams. Restoring these areas to support beneficial uses may be impossible because the dredged material takes up more space than it originally occupied, and because the fine-grained organic fractions needed for re-vegetation have been moved.

### *3.3.1. Effects of Mining*

The mining components that contribute to ground and surface water pollution include (Idaho Dept. Lands, 1992):

1) Roads
2) Open pits, quarry sites
3) Waste dumps, spent ore dumps, topsoil and ore stockpiles
4) Domestic and solid waste disposal facilities
5) Mill tailings impoundments
6) Settling ponds, process water ponds, slime ponds
7) Exploration operations
8) Maintenance of facilities
9) Petrochemical and miscellaneous chemical storage.

Sediment is a primary pollutant from these non-point source activities. Deposition of sediment on the stream bottom eliminates habitat for aquatic insects and fish by reducing the permeability of spawning gravels, reducing dissolved oxygen, and blocking the interchange of subsurface and surface waters.

Acid mine drainage can occur where sulfides are found. Sulfides exposed to moisture and air readily oxidize to form sulfuric acid. Effluent waters may have a low pH that is directly toxic to aquatic life. The primary metals released to streams by mining operations are arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, and zinc (Nelson et al., 1991). These metals exhibit lethal and sublethal effects on macroinvertebrates and fish.

Drastic changes may occur to stream hydrology and physical characteristics where surface mining alters the vegetation, soils, and subsurface materials. When the infiltration capacity of soils is reduced, overland and channel runoff lead to high peak stream discharges with subsequent channel erosion. In placer and dredge-mined areas, entire riparian areas have been replaced by unvegetated gravel piles with unnatural forced meanders and straight reaches with high gradient. These alterations have removed natural stream function and habitats necessary to support fish and wildlife.

### *3.3.2. Control of Mining Impacts*

Mining, because of the ubiquitous nature of its environmental impacts, is regulated by numerous state and federal laws. However, these laws are often inadequate to restore and protect water quality, since they do not address the cumulative watershed impacts of current and past mining activities.

Mining falls under the provisions of numerous federal statutes, including the Clean Water Act, Safe Drinking Water Act, and Clean Air Act. The Clean Water Act requires NPDES permits for point source pollution. Surface runoff is regulated as a point source under the Storm Water Regulations; there is debate whether it should be controlled as non-point source pollution under Section 319 of CWA. Mine operations on federal lands require operating permits which comply with the Multiple-Use Sustained-Yield Act of 1960 and the Federal Land Policy and Management Act of 1976. The federal Surface Mining Control and Reclamation Act of 1977 requires mining activities to minimize disturbance to fish, wildlife and related environmental values. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, amended in 1986 by the Superfund Amendments and Re-authorization Act (SARA) provides the authority for the cleanup of hazardous substances. CERCLA clearly assigns the liability for cleanup to owners, operators, and generators of wastes. The Resource Conservation and Recovery Act (RCRA) governs the generation and proper disposal of hazardous waste. Mining wastes are excluded from RCRA subtitle C due to the Bevill Amendment. The EPA Office of Solid Waste is formulating options for State Mining Waste and Materials Management Plans as an alternative to federal regulation under RCRA.

Mining falls under state laws that address mined lands reclamation, dam safety, stream channel protection, and water quality regulations. Because of the overlap of state and federal regulations, many states have attempted to develop one-stop permits for mining. This approach should improve the control of pollution to soil, air, and water, and include cumulative impacts from mining.

### *3.3.3. Assessment Procedures*

Assessment methods need to be tailored to the type of mining and impacts that are taking place; however, some general guidelines are useful. Individual site characteristics should be evaluated to design a monitoring program. These characteristics include climate, topography, geology, soils, seismicity, hydrology-hydrogeology, and elevation, slope, and aspect (Idaho Dept. Lands, 1992).

Runoff conditions are influenced by both climate and soil properties. Thus, information on total annual precipitation, storm/flood frequency, and seasonal temperature extremes is needed for evaluating runoff characteristics. Moreover, topography and geology provide information to evaluate runoff patterns, the stability of mine sites and facilities, and the sediment potential. Soil type and texture influence compaction, infiltration, resistance to erosion, and suitability for revegetation. Information on standing, flowing, and ground water within the mine site is used to assess surface and ground water discharges. Elevation, slope, and aspect all affect runoff and weathering characteristics.

Water chemistry monitoring focuses on the impacts of sedimentation, acid generation, mobilization of toxic metals, and petrochemical and reagent discharges. Sediment is measured directly as suspended sediment or indirectly as turbidity. Acidification is evaluated by measuring changes in pH. Heavy metals are measured as total metals in transported loads, and as dissolved metals to evaluate toxicity to aquatic life. Toxicity is evaluated based on indicator invertebrate and fish species in the drainage. Information on hardness and pH is required to determine appropriate metal criteria (U.S. EPA 1986). Water chemistry monitoring should be supplemented by biological monitoring since site characteristics may modify metal toxicity.

Biological monitoring should evaluate effluent toxicity and impacts to the benthic and fish communities. Macroinvertebrates are very sensitive to acid and toxic metal pollution. Evaluations use individual species indicators or community metrics for more subtle effects (Plafkin et al., 1989; U.S. EPA, 1990; Barbour et al., 1992). The benthic macroinvertebrate community integrates the effect of variable pollutant concentrations over time that cannot be detected by grab water quality sampling. Attached algae are also very sensitive to metal toxicity, and methods to evaluate periphyton are available (Aloi, 1990; Bahls, 1993). Chronic effects to the growth and reproduction of fish can be evaluated in addition to evaluating acute toxicity. On-site bioassays can be used to account for the synergistic and antagonistic effects of the stream water.

Physical and habitat monitoring are also required. Streams that receive flow from roads, open pits, and waste dumps should be evaluated for sediment deposition and changes in sediment transport characteristics. Methods used to evaluate sediment deposition include cobble embeddedness, percent surface fines, and Wolman pebble count. A recent procedure, the Riffle Stability Armour Index (Kappeser, 1993), may prove useful for the evaluation of cumulative impacts of mining on aggradation and degradation of a stream channel.

Stream habitat measures are applicable to some types of surface mining such as dredge and placer mining. Protocols that address channel shape, for example, width/depth ratios, streambank stability, pool quality, and streamside vegetative composition may be useful tools depending on the specific impacts (Platts et al., 1987; Bauer and Burton, 1993).

Water quality assessment is an on-going process that provides information to revise assumptions in the management plan. The first step is to critically review and evaluate the existing information that resides within various agency files. Data bases are developed for water quality, location of tailings, ore deposits, and mine portals. LANDSAT is being used to inventory mine tailings and spent ore deposits. Data for point sources and for non-point sources can then be used to develop a waterbody wasteload allocation. A comprehensive water quality plan, similar in scope to a Total Maximum Daily Load and Waste Load Allocation, can then be completed.

### 3.4. Urban Watersheds and Stormwater

Urban land uses generate non-point source pollutants that can influence water quality through oxygen demand, nutrients, toxics, heavy metals, bacteria, and sediment and heat from paved surfaces. Such sources should be managed on a watershed basis. For example, urban non-point source contributions must be included in the overall Total Maximum Daily Load (TMDL). Urban watershed management is strongly influenced by federal legislation, especially the NPDES program that requires permitting for stormwater outfalls. Combined sewer overflows (CSOs) are a major problem in many older cities. CSOs discharge a mixture of stormwater and sewage to receiving waters during storm events when interceptor and treatment plant capacity is exceeded. Management of urban runoff quality must be integrated with management of urban runoff quantity, and quality controls must be compatible with drainage and flood controls, often a difficult task in older cities. Retro-fitting of flood control devices for enhanced water quality represents a major need for established urban watersheds; it is often not clear how this is best attained.

Assessment methods for urban runoff quality vary from straightforward data analysis to complex models (Donigian and Huber, 1991). From the modeling standpoint, there has been a lack of emphasis on biological indicators other than those commonly treated as a chemical constituent (for example, BOD, bacteria). Thus, water column chemistry is the primary focus, with special consideration given to sedimentation problems. Habitat considerations are seldom addressed, although there are instances of salmon run restoration (for example, Bellevue, Washington).

Management options for urban watersheds are many, including various forms of stormwater storage, infiltration, treatment and source control (for example, Urbonas and Roesner, 1986; Roesner et al., 1988; Torno, 1989). Storage options include retention (with subsequent infiltration and evaporation of the stormwater), detention in ponds with permanent water storage ("wet ponds"), or detention in ponds that are dry between storm events ("dry ponds"). Constructed wetlands offer another storage option that enhances sedimentation and nutrient removal. In-line storage (storage in the sewer system itself), concrete tanks, and even deep tunnels have been employed in older cities. Sedimentation during storage of stormwater provides some treatment to decrease pollutants. Storage of combined sewage is used to detain the runoff for subsequent treatment at the municipal sewage treatment plant, although there may be some pollutant reduction during detention as well. Secondary flow devices such as swirl concentrators are sometimes used to concentrate solids in the portion of flow diverted to treatment.

Developing urban areas must decide whether to employ distributed storage, that is, smaller ponds at several development sites, or to utilize a larger, regional facility. The former option has the advantage of control closer to the source, but suffers from maintenance problems if the ponds are not publicly owned. The latter option enjoys economies of scale and simpler public maintenance, but requires a larger segment of public land and may offer control far from the source. Maintenance is the key to successful stormwater control in urban areas for any structural method.

The predominant difference between urban and non-urban watersheds is the abundance of impervious area from roofs and streets, as well as the hydraulically improved drainage system of channels and pipes. Enhancement of infiltration is thus another mitigation option through ponds, overland flow, and porous pavement. Overland flow in roadside swales has the additional advantage of particulate removal.

Treatment via sedimentation is a part of any storage control, and high-rate treatment (for example, dissolved air flotation), screening, and/or chlorination is sometimes employed for CSOs. Nutrient removal is usually through a biological mechanism as part of wet ponds and wetlands options. Treatment that is not a part of a storage scheme is usually too expensive for implementation. Sedimentation from construction site runoff and other urban activities is best controlled at the source on a site by site basis. Some states (for example, Maryland, Delaware) have excellent, enforceable regulations for sediment control.

Source control through public education and regulatory vigilance has great potential for pollution reduction, especially elimination of illicit connections to storm sewers from industries. Storm sewers should not be flowing during dry weather, nor should CSOs occur during dry weather. Illicit connections can be the cause of such phenomena, as well as uncontrolled infiltration and inflow into the sewers.

Although federal laws drive the regulatory process, local governments must pay for management of urban watersheds. In the absence of federal dollars, innovative financing schemes include stormwater utilities where taxes are levied on the amount of impervious surface. Most homeowners, however, pay only a flat rate of typically $3–5 per month. Variable rates encourage industries and commercial developments to minimize imperviousness and provide maximum on-site control of runoff and pollution. Citizen involvement is the primary means by which less quantifiable objectives such as habitat restoration and aquatic life diversity in urban watercourses may be realized.

## 4. THE POLICY BASIS FOR WATERSHED ASSESSMENT

Assessments of watershed condition and cumulative effects are carried out as part of public policy. Policy includes social goals, and the objectives required to develop and manage environmental resources in accordance with these goals. Public policy also includes laws and regulations, and the technical and scientific expertise available. Non-point source pollution control on a watershed basis involves management of public and private lands. Management changes for watershed protection on private lands are frequently undertaken on a voluntary basis by the landowners, often with education and sometimes with incentives from public funds or regulatory mandates.

Watershed assessments can include descriptions of the current biophysical, social, economic, administrative, legal and political environment. Alternative policies are identified from these assessments, followed by selection and justification of the preferred policy. Implementation should be followed by monitoring to evaluate results. The watershed processes that are least understood may be the most important for evaluation of policy. Pressure to produce rapid assessments that are defensible in court works against inclusion of cumulative effects assessment or studies of processes.

Land management changes being implemented or considered include voluntary and incentive-based efforts to control degradation of watersheds. Improved planning and regulatory capacity is a necessary precondition for successful implementation of a tradable pollution rights programs (Lence, 1991; Willey, 1992). However, stringent regulations on private land to protect water quality and avoid adverse cumulative impacts raise unique policy, constitutional, and other legal questions. While the water quality impacts of watershed land uses are externalities potentially subject to regulatory control, the political will and the legal authority to apply regulatory solutions have evolved slowly. Also, current federal and state fiscal constraints limit the resources available for staffing to administer new regulatory initiatives designed to protect and improve water quality within a watershed. All these factors suggest that, wherever possible, integrated watershed management should be implemented within existing laws and institutional arrangements, such as the EPA's Watershed Protection Approach (Weatherford 1990).

Some examples of Pacific Northwest strategies for protecting water quality in watersheds include: The Governor's Watershed Enhancement Board Program in Oregon's Strategic Water Management Group; Oregon and Washington's Lower Columbia River Bi-State Water Quality Program; the National Estuary Program designation for Puget Sound and Tillamook Bay; Idaho's Agricultural Pollution Abatement Program; and Washington's shellfish protection legislation. Examples of local innovative programs are the Coquille River water quality project and the Integrated McKenzie Watershed Program in Oregon.

While federal pollution control law focuses on water quality, state water law governs the allocation of water for in-stream and out of stream uses. States own the beds of navigable rivers and lakes, subject to the public trust doctrine, while the adjacent landowners share ownership of the beds of non-navigable water bodies. Diversions for water uses have not been controlled to protect water quality under federal and state pollution control laws, because a number of small, individual uses are involved and because of a tradition of respecting water quantity allocations as property-like rights. For example, irrigation return flows are specifically excluded from point source control under the Clean Water Act (CWA), leaving irrigated agriculture, the largest water user in the West, mostly uncontrolled.

Within state water law, there is now increasing legislative and judicial allocation of water to in-stream uses such as fish, wildlife habitat, and recreation. Proposed diversions of water from streams are also being denied or modified based on federal and state pollution control, wetlands, and species protection legislation. Watershed approaches are possible but not required within the current legal and institutional framework. Adequate discretionary authority exists for improving water quality in three major areas: reduced water diversions, reducing watershed pollutant loadings, and watershed habitat improvements.

The next sections will describe statutes that relate to watershed assessment. A more complete discussion of the legal and policy basis for watershed approaches to water quality protection, including cumulative effects, is given in Appendix C, "Legal and Policy Analysis for Integrated Watershed Management, Cumulative Impacts and Implementation of Non-Point Source Controls.

## 4.1. The National Environmental Policy Act (NEPA)

The concept of cumulative watershed effects was defined in the National Environmental Policy Act in 1969 and again by the Council on Environmental Quality in 1971. A cumulative effect, as used here, is any environmental change caused by a combination of land use activities (Reid, 1991). This includes past as well as foreseeable future activities.

The effects of seemingly small, independently made decisions can accumulate to create unexpected and significant consequences. Small decisions on resource use are usually made separately, without addressing the combined consequences of the decisions, and with no provision for analyzing the perturbations or their effects over large areas or long periods. A simple example in forestry is the combination of harvesting, roads and reforestation activities in a watershed. Cumulative effects analysis has been used more widely in forestry than for other land uses.

Under the National Environmental Policy Act (NEPA), federal agencies are required to prepare preliminary environmental assessments to determine whether the proposed activities are a "major federal action" which will "significantly [affect]...the quality of the human environment." If so, then the agency must prepare a more comprehensive environmental impact statement (EIS), complete with a review of cumulative impacts, in order to consider the full range of environmental implications and alternatives.

Even if an agency action has not been formally proposed, it may still require NEPA scrutiny under the concept of "connected actions," which are "closely related and therefore should be discussed in the same impact statement." Such actions are "connected" if they 1) will automatically trigger actions requiring environmental impact statements, 2) cannot proceed unless other actions are taken previously or simultaneously, or 3) are interdependent parts of a larger action and depend on the larger action for their justification. Thus, connected actions may require an agency to assess the cumulative impacts from timber harvesting, even though it only proposed to build a logging road, since timber production would follow road construction.

## 4.2. The Clean Water Act (CWA)

The Clean Water Act (CWA) is the primary statutory vehicle for protecting the quality of ground and surface waters in the United States. The Federal Water Pollution Control Act of 1972, Section 208, called for states to develop best management practices (BMPs) to control non-point source (NPS) pollution. Control of NPS pollution was formally listed as a national goal in the 1987 amendments to the CWA; Section 319 called for states to develop assessment reports and management programs to address NPS pollution. States submitting satisfactory reports and programs to EPA became eligible for federal matching funds to implement their NPS management programs. Section 319's voluntary compliance scheme continues Congress" traditional deference to state law in areas such as land use regulation, which have typically been under state and local purview.

The Watershed Protection Approach (WPA) Framework Document (U.S. EPA, 1991) reflects the EPA's expanding commitment to addressing water quality problems in a comprehensive, holistic fashion. WPA established three central goals: address NPS pollution in a holistic manner to meet specific NPS goals based on human health and ecological risk factors; coordinate federal, state and local NPS efforts through technology and information sharing; and empower all levels of government to implement watershed-specific management plans. Cumulative chemical, biological and physical effects were to be considered, and progress assessed by developing finite NPS goals and milestones.

Where water quality does not meet the standards required for the specified beneficial use(s), an allocation must be made for all contributing sources of pollutants. This is the Total Maximum Daily Load (TMDL). While the TMDLs and other water quality-based approaches appear sound, there are inherent difficulties in calculating and implementing them. Although the EPA has a strong commitment to helping states promulgate water quality standards and

TMDLs, few states have yet committed the financial and technical resources to actively pursue effective water quality-based regulation.

### 4.3. The Endangered Species Act (ESA)

For specific watersheds and river basins, ranging in size from the Columbia-Snake to the Klamath or smaller basins, applications and pending applications of the Endangered Species Act (ESA) have had and will have significant impacts on watershed management. Management for protection of endangered species could significantly improve water quality. The United States Supreme Court and the lower federal courts have consistently interpreted the ESA as favoring species survival over other considerations.

The ESA mandates to prevent injury to designated species or their habitat apply broadly to all private, local government, state, and federal actions on private, state, federal, or other public lands in the watershed or basin. In assessing the risk of injury, the cumulative impact of activities within the watershed or basin must be considered. Because a primary purpose of the ESA is to preserve the habitats of species listed as threatened or endangered, designation of "critical habitats" under the ESA provides a potentially powerful legal mechanism for the protection of watershed values.

### 4.4. The Coastal Zone Management Act (CZMA)

Section 6217 of the 1990 amendments to the federal Coastal Zone Management Act (CZMA) created a Coastal Non-point Pollution Control program that could prove significant in maintaining and improving water quality in coastal watersheds. The leading sources of NPS pollution in estuary waters are urban runoff and agriculture. The EPA's guidelines for CZMA specify management measures to control NPS from agriculture, silviculture, urban development (including construction, septic tanks, highways, bridges, and airports), hydromodification (including dams, levees, impoundments, and shoreline erosion), and marinas as the focus for state coastal NPS programs.

CZMA section 306(d)(16) requires state coastal programs to contain "enforceable policies and mechanisms to implement" the states" coastal NPS programs. This requirement distinguishes coastal NPS programs from existing NPS efforts such as the Soil Conservation Service agricultural programs or the Clean Water Act Section 319, which are voluntary. However, coastal NPS management measures including land use controls, will not be enforceable under federal law; instead coastal NPS programs will be developed, implemented, and enforced by the states under state law.

Definitions used by the states in defining their CZMA coastal zones vary. The required boundary evaluations could be crucial in ensuring that the states use ecologically rational boundaries to manage coastal NPS pollution. However, defining the coastal zone's inland boundary was a very sensitive issue in the initial development of many state coastal programs (Powell and Hershman, 1991).

Coastal states can be expected to employ both technology-based and water quality-based approaches to NPS management. EPA's goal is to have the states immediately use accepted management practices to reduce NPS pollution, while implementing additional measures to address more complex water quality problems. Improved management of NPS pollution sources would be a major step toward the overall goal of an integrated watershed approach to water quality problems.

The EPA Region 10 staff in Seattle have strongly urged the EPA and the National Oceanic and Atmospheric Administration (NOAA) to allow the Region's coastal states to take a watershed protection approach (U.S. EPA, 1992) in implementing CMZA. Watershed approaches allow the states to prioritize their efforts on a watershed-by-watershed basis, increasing flexibility and efficiency in allocating the relatively small resources available for NPS pollution control. According to Region 10 staff, "The reason for controlling non-point sources is to meet the Clean Water Act goal of protecting the physical, chemical, and biological integrity of the Nation's waters. This requires consideration of overall habitat issues which are best done on a watershed basis" (Gakstatter, 1991).

### 4.5. FEDERAL MANDATES FOR AGRICULTURE: THE SCS

The Soil Conservation Service (SCS) and the Agricultural Stabilization and Conservation Service (ASCS) were established in 1935 and 1936 to address soil erosion resulting from agricultural practices. These Department of Agriculture (USDA) programs authorized soil and water conservation districts to control soil erosion, to conserve and develop water resources, and to protect water quality. The districts assist private landowners in voluntary application of erosion control measures. In addition, the Food Security Act (Farm Bill) of 1985 included conservation measures in sodbuster, swampbuster, conservation compliance, and conservation reserve programs.

Federal programs under the SCS and the ASCS have the potential to fund watershed improvement programs at the state level under Hydrologic Unit Area and Water Quality Demonstration Project programs. The Conservation Reserve Program and the Environmental Easement Programs under the 1990 Farm Act may also be important in conserving and setting aside riparian areas. The SCS gives assistance to state and local watershed projects through the Small Watershed Program Grants. The ASCS administered the Rural Clean Water Program (RCWP), created by the 1977 amendments to the Clean Water Act. The goal of the RCWP was "installing and maintaining measures incorporating best management practices to control non-point source pollution for improved water quality."

Diversions of water for irrigated agriculture have generated increased scrutiny. Voluntary and involuntary reallocations of water for in-stream purposes are being requested. However, the legal framework addressing agriculture's pollutant load in watersheds remains incomplete. Irrigation return flows are exempted from the Clean Water Act's elaborate point source discharge permit system. Control of these pollutants depends on state NPS and coastal NPS programs, on largely voluntary and somewhat fragmented federal, state, and local soil conservation programs, or on special state agricultural pollution control programs such as Idaho's. Water districts serving irrigated agriculture can play key roles in implementing any state agricultural pollution control program that is established (Davidson, 1989; Foran et al., 1991).

## 4.6. Federal Interests in Watershed Management

Laws on management of federal public lands generally require the designated federal land management agency to consider watershed values from a multiple-use perspective. Within that framework, the agencies have considerable discretion to implement integrated management approaches that protect watershed water quality, including programs coordinated with private and public landowners upstream and downstream from the federal watershed lands. Stronger mandates to protect watershed water quality are triggered when federal resource protection laws such as the Endangered Species Act and Wild and Scenic Rivers Act are applied to federal, private, and other public lands in a particular watershed. These requirements generally support implementation of an integrated watershed approach.

The National Park Service Organic Act requires the National Park Service to preserve the wildlife and scenery of certain congressionally-designated park areas. As urban and resource development encroach on park lands, courts may require greater Park Service attention to out-of-park activities injuring in-park values. The Park Service's management policies and guidelines are not enforceable regulations so the potential for effective water quality management, including cumulative impact analyses for in-park and out-of-park activities, appears to be limited.

The Wild and Scenic Rivers Act of 1968 preserves the free-flowing condition of certain river segments for their special scenic, recreation, biologic or other values. Agencies with jurisdiction over designated areas retain management responsibilities, and have broad discretion in carrying out the Act's mandates. The courts have held that these agencies have a continuing obligation to take whatever actions are necessary, including consideration of recommendations from the EPA or state water quality agencies, to protect both the quality and quantity of water in the designated waterbodies. The courts have upheld restrictions on the development of hydropower and other impoundments which adversely affect wild and scenic river values.

Since the landmark ruling in U.S. v. New Mexico (438 U.S. 696, 1978), the courts have been averse to granting in-stream flow rights to the USFS within National Forests under federal law as federal reserved water rights. Because in-stream flow rights are important elements in the protection of watersheds, the courts reluctance to recognize such rights inhibits effective water quality management in National Forests. However, under the Forest Service Organic Act of 1897, the USFS appears to have broad authority to "secure favorable conditions of water flows." At least one state court has interpreted such authority to extend to the reservation of in-stream flows (U.S. v. Jesse, 744 P.2d 491, Colo. 1987). Federal agencies also have been successful in obtaining nonconsumptive water rights under state water law apart from any claim of a federal reserved right (State v. Morros, 766 P.2d 263, Nevada 1988).

The Multiple-Use Sustained-Yield Act recognizes the watershed resource as a "coequal multiple surface use," to be considered by agencies charged with managing federal lands under the notions of sustained yield. The National Forest Management Act requires preparation of forest-wide management plans for timber harvests within the National Forest system. These plans must "insure" that timber harvesting will not result in irreversible damage to watersheds, wetlands, or water quality.

The Federal Land Policy and Management Act (FLPMA) seeks to inject more formal, systematic land use planning into BLM's administration of mining, logging, off-road vehicles and other uses on federal lands. Under FLPMA Section 202, BLM must abide by certain criteria, including compliance with applicable state and federal pollution laws, when establishing land use plans on federal lands.

The Federal Power Act allows the Federal Energy Regulatory Commission (FERC) to license non-federal hydropower facilities on federal and non-federal lands. The 1986 amendments to the Act require FERC to conduct a public interest review of proposed licenses and to give equal consideration to power development and environmental protection. At least one court has held that FERC must consider cumulative impacts from successive projects within watersheds when developing its comprehensive plans (LaFlamme v. FERC, 852 F.2d 389, 1988). Additionally, if the proposed power project would "significantly affect the quality of the human environment," FERC is required to comply with the mandates of NEPA which include cumulative impacts analyses (National Wildlife Federation v. FERC, 912 F.2d 1471, D.C. Cir. 1990).

## 4.7. State Interests in Watersheds

Watershed management and non-point source pollution control are land use issues under state jurisdiction. The mandates of Section 319 of the Clean Water Act and the 1990 reauthorization of the Coastal Zone Management Act have increased interest in developing watershed-based water quality management programs.

In Washington, a new state law designed to protect shellfish growing areas from non-point source pollution authorizes counties to create shellfish protection districts in areas where pollution threatens shellfish harvesting. The shellfish program will address pollution from stormwater runoff, sewer systems, animal grazing and manure management practices, and includes public education. The Shellfish program amended Washington's land use laws under the Growth Management Act. Comprehensive land use plans will provide for the protection of public water supplies and water quality in shellfish bedding areas.

In Oregon, existing programs including the Forest Practices Act, state land use goals, the NPS pollution program, and the work of the soil and water conservation districts, are conducive to statewide watershed management. The Oregon Department of Environmental Quality (DEQ) initiated a pollution prevention program called the Non-point Source Statewide Management Program for Oregon, which emphasizes the use of BMPs to avoid creating critical water quality problems in a water basin affected by a variety of non-point sources. Objectives of the program include assessing cumulative effects mostly through the TMDL approach under section 303 of the Clean Water Act. Riparian areas and wetlands are also part of the NPS program (Oregon DEQ, 1991).

The Oregon Land Conservation and Development Commission has established a comprehensive statewide program of land-use planning. The 19 land-use goals are implemented through the adoption of local comprehensive plans, which must be consistent with the statewide goals. Several of the land use goals include water management objectives. Goal 5 mandates the inventory of fish and wildlife habitats, potential and approved federal wild and scenic waterways and state scenic waterways, and watershed and groundwater resources. Goal 6 mandates that future and existing development and land uses be coordinated to maintain water quality standards. In 1988, the Oregon Water Resources Commission approved a modification in the basin-by-basin planning system, adding an element on state-wide water policy.

The Washington Timber, Fish and Wildlife (TFW) Agreement is an example of how conflicting uses within watersheds may be resolved through participation of affected user groups in the policy-making process. TFW is an agreement reached by consensus among representatives of groups affected by forest practices and resulting impacts on fisheries, wildlife, and water quality. Participants agreed that forest management should be conducted in such a way as to maintain and protect fisheries, wildlife, water quality and quantity, cultural resources, and timber supply. The TFW process works with the Department of Natural Resources (DNR), which regulates forest practices. A new management system to incorporate TFW suggestions and improve coordination includes changing the structure of DNR, creating interdisciplinary teams to evaluate technical forest practices, and improving public participation and access to agency decision making. The TFW agreement includes addressing cumulative impacts.

Local soil conservation districts in Idaho administer the Idaho Agricultural Pollution Abatement Program to address agricultural NPS pollution in identified watersheds. The soil conservation districts enter into voluntary agreements with private landowners who agree to use BMPs to abate NPS pollution. The state provides funding for local watershed programs through inheritance, tobacco and sales taxes.

# 5. CHOOSING AN APPROPRIATE MONITORING SYSTEM

## 5.1. OVERVIEW

Ultimately, watersheds need to be monitored to meet the goals of NEPA, the Clean Water Act, state and regional legislation, and for the protection of existing and future beneficial uses. Undisturbed watersheds need monitoring to provide baselines for regional environmental quality; disturbed watersheds need monitoring to evaluate the condition and the success of recovery strategies.

The first step in adopting a watershed monitoring system will be to agree on the goals of the assessment, and to determine how the responsibilities can be shared among the parties. This step is crucial because it will determine the level of commitment by various parties. Managers will have to work with a variety of landowners, and have to cross agency and political boundaries to conduct assessments. Watershed assessment and protection is more than a science, it is a political step that can lead to changes in:

| | |
|---|---|
| access and easement | land use |
| agency spending patterns | range management |
| agricultural cropping patterns | recreation uses |
| domestic animal management | reservoir management |
| erosion control | urban development patterns |
| fire management | vegetation management |
| fisheries management | water supplies |
| in-stream flow requirements | wildlife management |
| in-stream structures | |

Because watershed improvement will involve many changes, it is critical that all players be committed to implementation. Because the nature of the changes will depend on the assessment process, commitment to implementation will depend upon the parties" involvement in the watershed assessment.

Watershed assessments are based on a set of assumptions that are generally inherent in the choice of assessment system. Figure 4 shows the decision making path that determines watershed assessment choice. The path starts with the context or the statement of a problem. Next, the managers recognize constraints to their problem's assessment. Finally, they choose a system that reflects their interest in the present (an inventory) or the future (a model).

Unfortunately, many resource assessments are made without this level of forethought. Managers may want to gather data because it appears useful but may lack a clear direction or data reduction and use strategy. They may choose a system that appears to answer their needs but is too difficult, costly, or variable to yield useful information. Resource users may purposefully choose a system that "averages away" negative impacts, in order to fulfill institutional and legal requirements. Even best-intentioned professionals may choose an assessment system that yields good information, but is of limited applicability; the plan may be impossible for others to implement, or it may require management changes not currently available or enforceable.

## 5.2. CONTEXT

Recognizing the context of a problem is a critical, creative, productive, and empowering step in beginning an assessment. It allows all parties to identify beneficial uses, to suggest impact sources, to agree on time and space parameters, or to venture management strategies for their watershed. Then, as a group, parties with joint responsibility for a watershed may agree on the problems they wish to solve, the bounds of time and area that the problems exist in, and the science that may be necessary to develop a useful assessment.

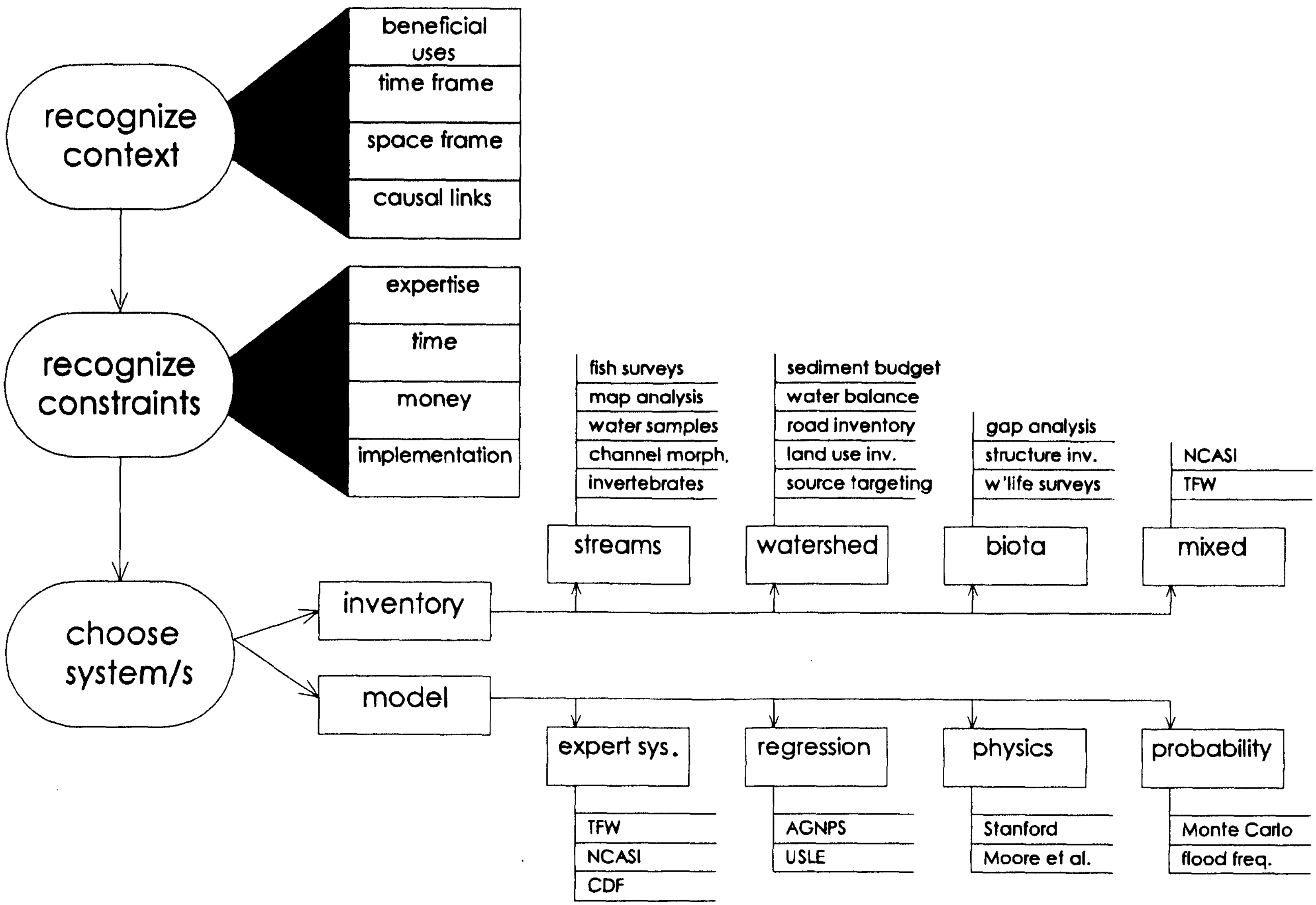



**Figure 4. Decision Making Path for Watershed Assessment Systems**

The hidden benefit from discussions of context is hearing the other parties' perspectives directly, and putting a human face on a given point of view. Individuals are easier to work with than stereotypes. General concepts necessary to understand the context of watershed assessment are discussed in the following sections.

### *5.2.1. Actor to Receptor*

Effects occur when beneficial uses receive impacts created by given actors. The fragility, resilience, or restoration capability of given beneficial uses all vary with regard to different impacts. Similarly, the ability of agencies, communities, or particular restoration techniques to control given actors also varies.

Identifying actors and receptors allows the assessment of impacts to be viewed in context. Identification allows the assessor to make the statement "Actor A is affecting Receptor B, limiting its ability to provide Level C of beneficial use." When framed within time and space parameters and by incorporating probabilities of occurrence, identification of actors and receptors begins the search for assessment strategies.

It is rarely simple to make definitive statements about watershed impacts. Generally, individual impacts combine to reduce a beneficial use, and it is very difficult to identify individual sources of degradation. The development of an impact assessment to reduce the degradation requires recognition of both the specific agents of change and the resources or uses that they are affecting. The Washington State Forest Practice Board's (WFPB) "Standard Methodology for Conducting Watershed Analysis" developed under the Timber, Fish and Wildlife Agreement (TFW) approaches this problem with "statement-building," giving a specific structure for impact-defining language (WFPB, 1994). Another example is the method (Megahan, 1992) developed for the National Council on Air and Stream Improvement (NCASI) of the Pulp and Paper Association.

### *5.2.2. Time and Space*

Different assessment systems imply different contexts of time, space, and point of view (Levin, 1992; Euphrat, 1992). Sampling procedures vary from point-in-time/point-in-space water samples to long-term/large scale assessments of geologic and human-induced processes, as in a sediment budget. Given the complexity of watershed analysis, larger scale analytic methods are often appropriate. Cumulative effects analysis requires the assessor to evaluate impacts into the foreseeable future. Case law for logging in California requires evaluation ten years into the future. In-stream methods are often still applicable, particularly in understanding the processes such as sediment transport, where much of the total annual movement may occur in only a few days. In-stream sampling may represent longer time periods and larger areas than the particular point of the sample.

As one watershed differs from another, so do the development of watershed processes, the benefits they produce, and their responses to impact. Benefits are measured with specific scales such as animal-unit-months, board-feet per acre per rotation, gallons per minute of water, annual salmon runs, and visitor-use-days. Measurements of watershed processes and impacts need similar specific measurements, such as large woody debris per mile of stream, inches of rainfall per year, water temperature, miles of road, or tons of sediment per subwatershed per century. Because the benefits derived from watersheds are closely tied to watershed processes, monitoring has been expanded in many cases to processes and impacts. The result is a monitoring system that can better analyze the resource, doing so by measuring data at varying scales and perspectives. In too many cases, data are still poorly integrated through management agencies, collected redundantly, collected and "lost," or collected without the knowledge of other parties. Creation of information systems for watersheds, including data of many scales and disciplines, allows meaningful watershed analysis.

In response to the need for watershed assessment at different aerial scales, the Federal Ecosystem Management Assessment Team (FEMAT) identified analysis methods for regions (state, multi-state), hydrologic provinces and river basins (thousands of square miles), watersheds (tens to hundreds of square miles), and sites (up to hundreds of acres) (FEMAT, 1993). The TFW assessment approach suggests initial surveys for basins of 10,000 to 50,000 acres, with more in-depth study of smaller areas, which require greater expertise and planning time (WFPB, 1994).

With longer and more integrated records, resource managers get a better picture of seasonal and annual variability, and of different components that affect the benefits provided by the resource. A better data base ultimately allows managers to distinguish between trends in watershed health with natural variability and seasonal cycling. A good statistical base to support data collection will make it robust enough for different kinds of analyses. Data collection is the heart of the interpretations required for adaptive management practices for watersheds.

Watershed assessment requires monitoring a range of processes and their interactions to interpret cumulative effects. To determine the source of sediment in a stream, for instance, one can monitor sediment production from all sources such as streambanks, roads, wildlands and developed areas. To determine why fish populations are decreasing, one can monitor local catch, returning fish, hatchery inputs, habitat condition, precipitation, and sedimentation. A long-term and complete record allows managers to respond to problems according to their relative size and duration, and not to focus exclusively on the most visible symptom of environmental change. Because short-term, small-area phenomena are the easiest to measure (a photo, a water sample, or a single bird survey are examples), the public and managers often make decisions based on a scale that is ineffective in resolving the actual problem. A range of watershed assessment tools are shown relative to their time and space scales in Figure 3.

The diminution of effects over time and distance compounds the problem of watershed assessment. A severe impact may create a profound initial effect, then generate smaller effects as it recovers over time. Similarly, the measured effect is greatest in the immediate area of impact, and reduces as the area of assessment increases downstream or across the landscape. Reduced impacts do not go away, however, and may be important elements in long-term cumulative effects far from the time and date of the initial impact. Assessing the effects of habitat impacts should cover a time scale as long as a full maturation cycle for vegetation, the periodic population cycles of a fishery, or the centuries or millenia level for long-term changes in sedimentation. All of these scales recognize the importance of infrequent, high impact events, and the inherent variability of the resource over time and across the landscape.

### *5.2.3. Flow Paths*

Another important perspective in impact assessment is the definition of the paths of impact flows relative to specific beneficial uses. This perspective is useful in understanding both the reduction in beneficial use and the nature of the assessment strategy that will be necessary. Impacts may concentrate, disperse, or be evenly or unevenly distributed across the landscape. Environments and their beneficial uses may be resilient or impacts may be irreversible. All of these factors are elements of an impact's context.

Some impacts accumulate in watersheds, and hence are particularly amenable to watershed analysis. As material moves downhill through the stream system, the channel concentrates some of the impacts. Sedimentation is a good example of concentrated impacts, as is eutrophication from in-stream grazing. Storm sewers also act like streams, collecting oil and grease in their runoff. In these cases, impacts or particular pollutants may be evaluated in the stream system.

Dispersed effects, such as air pollution, noise, some forms of fertilization, or exotic plants and animals, are free from entrainment by water, but may have important impacts on watersheds. These effects are normally measured by surveys or transects reflecting concentrations and accumulations across the landscape.

Unevenly distributed impacts are also measured by surveys. Roads and landslides, for instance, may be measured in photos. Leaking underground storage tanks are located and assessed from maps and monitoring wells. Vegetation patterns are determined from maps, photos, and ground surveys. Wildlife patterns, including the presence, absence, or densities, are measured by transects of both animals and their indicators.

### *5.2.4. Causal Links*

Causal mechanisms, or links, are those factors which transmit impacts from a project or natural process to the beneficial use. In some cases, we can clearly envision how that mechanism works. Urban oil and grease, for instance, is washed off the streets into storm drains and moves from the storm sewers into receiving waters. Even when the mechanism is apparent, however, the larger picture may not be easily discerned. What percent of oil is directly poured into sewers and what percent originates as runoff from the streets? In this case, the causal mechanism for pollution is both in the physics of oil and water and in the habits of urban populations.

Assessment systems must recognize which causal links are important to the resource of concern, and within which time frame or spatial boundary they operate. Regulators may not be able to address pollutant sources originating on private property, for instance, and are even less able to limit "acts of God." The greatest problems arise when causal links are incorrectly assumed. Incorrect assumptions can allow real problems to increase while the assessment system registers no change.

Some indicators imply causality, but their use may not be generally valid. The Forest Service's Equivalent Roaded Area (ERA) (Haskins, 1983) was developed to indicate the potential of increased water flows from timber harvesting areas, but has been used as an indicator of cumulative watershed effects and sedimentation. The connection between physical changes measured by the ERA and those changes which it is supposed to indicate are not physically based. The indicator is appropriate for what it explicitly measures: roads, landings, and timber harvest history in a defined watershed.

Some assessment systems recognize causality. The TFW system evaluates actions, watershed process input derived from those actions, and the resulting effects within time and space frames, with conditions and modifiers (WFPB, 1992). The FEMAT report describes watershed analysis with components of watershed conditions, likely impact mechanisms, existing impacts, altered conditions (effects), and pathways of influence along which impacts propagate (FEMAT, 1993). In both these systems, the analysis of causal links between previous impacts and current conditions becomes the basis for predictions of future environmental change.

## 5.3. Constraints

Research information is needed to form prescriptions, but watershed conditions continue to degrade during the time of the investigation, changing the ultimate prescription. Research must be responsive to the managers" needs on a short time scale. MacDonald et al. (1991) offer guidelines for water quality assessment that address the question of constraints to research. They evaluate systems with reference to the time, money, and expertise necessary to conduct the assessment. Their purpose is to direct managers to the program that will meet their objectives within explicit constraints.

Because watersheds are relatively large and contain long-term features, a research program must be limited in scope if it is to develop practical answers. The main constraints to watershed assessment include the goals of inquiry, time, area and access, funding, personnel, and baselines. Clear goals of inquiry are based, in part, on local political, social, and traditional settings, and constrain watershed assessment because they require community involvement prior to initiating any other actions; in return, effective community involvement alleviates other constraints. Time becomes a constraint when the processes being affected by impacts are cyclic, sporadic, long-term, have extreme variations in intensity, or have long recovery periods. Area and access determine the physical scope and ease of the assessment's implementation. Funding is a perennial constraint, because it increases landowners" short-term costs for unpredictable or non-cash, long-term gains. Personnel may limit the choice of assessment systems because of individuals" expertise, their field training, and the experience needed to collect data. Baselines constrain research because there are few undisturbed watershed ecosystems that have been monitored over time, and because the data that have been collected may not fill present information needs. These individual constraints are described in greater detail below.

### *5.3.1. Goals of Inquiry*

The most useful data is that collected for a specific purpose. The data is sought to answer a specific problem, is double-checked in the field, and analyzed when brought back to the office. The data become an important element in the solution of a larger problem.

Often, certain beneficial uses have already been degraded when a watershed assessment begins. Those degradations may have occurred under a variety of management practices, and thus are effects from a suite of cumulative impacts. As people try to determine "the source of the problem," they frequently consider single answers to the most pressing or obvious impact.

Experience shows that simple cause and effect relationships are rare in watersheds. The size, natural processes, time frame, and variety of both uses and impacts within watersheds preclude simple answers. In fact, oversimplification is an easy way to assign blame to the other person. It is important, therefore, to have extremely clear goals of inquiry; the purpose of the watershed assessment must be stated at the outset.

A useful form of inquiry is the scientific method, or hypothesis testing. The objective of the study can be stated clearly in a sentence, which may then be proved or disproved by data within statistical bounds of certainty. The study can be duplicated by other researchers, who should reach the same conclusions. Causal links must be justified by literature, analysis, or the study itself.

Many watershed studies fail to meet the requirements of these parameters. General indicators of a condition may not be justified, the number of replicates within the study are not statistically strong, and the relationship between reductions in beneficial uses and pollution indices may be unclear over relevant time scales and areas.

The most difficult aspect of watershed assessment may be forging agreement among the involved parties on the goals of the inquiry. People may not reach consensus on the present or future quality and importance of a specific beneficial use. The parties must agree on acknowledged, presumed, and suspected causal links that hamper a beneficial use because the study can only answer the questions which it asks. All parties must agree that the answers developed from the study will be useful enough to act on, and that the participants in the study are acting in good faith.

Section 6 of this report will introduce a variety of watershed assessment methods, representing different approaches to watersheds, to science, and to goal-directed inquires. Each approach was created in response to a specific set of goals which are described in the original reference. Many approaches were developed as field methods and designed to be easily applied by non-technical personnel. Different goals demand different approaches, with different levels of resolution, areas of focus, assumed causal links, levels of staffing and expertise, and amounts of funding. These constraints are revealed in the data and in the types of recommendations yielded.

The key to the selection of a system for a particular watershed will be determining the intrinsic goals of inquiry. All these watershed assessment systems were designed to meet specific criteria, and to yield recommendations within specific policy environments.

### *5.3.2. Time*

Watershed processes are slow. The geomorphic processes of watershed formation may have taken millions of years to form the current landscape. Other long-term phenomena include natural erosion rates, floodplain formation, old terrace formation, and stream channel movement. Soils are also slowly developing features, forming over hundreds to tens of thousands of years on floodplains and hillslopes. An old soil may be the product of a million years of evolution in an isolated environment.

Vegetation processes are more rapid than geologic processes but are still long-term compared to policy decisions. A coniferous forest may reach a "climax" ecological stage in 200 to 500 years, having passed through seral stages of grasses, brush, hardwoods, and other conifers. The habitat in that forest environment takes longer to develop because it requires the elements of decay up to and including the late seral stage, including downed large wood, standing dead trees, large wood in stream channels, and gaps in the mature forest created by fire, windthrow, or disease.

The extreme events that mark habitat creation within forests may be catastrophic, occurring in a brief time span relative to the age of the forest. Similarly, geomorphic processes include important channel-changing, soil-building, stream-modifying events that happen quickly, but have impacts for decades, centuries or millennia. Landslides, extreme floods, and intense storms are natural events which may strongly affect watersheds. Examples of human events of this magnitude include road building, dam building, or river channelization.

Other events may occur gradually and be dependent on the seasons or individual years. Lakes undergo seasonal changes in dissolved oxygen based on their shape, depth, temperature, and plankton populations. Turbidity tends to "spike" with the first storms of the year, reflecting soil disturbances during the dry season. Insect populations in streams may be depressed following high flows, then increase as substrates stabilize and their numbers recover. Biological impacts of cattle on streams are probably greatest when water flow is lowest, temperature highest, and at the end of the grazing season.

This general discussion of time constraints is intended to emphasize that watershed assessments must recognize the role of timing with respect to specific measurements. An assessment system must focus on only those components that reflect meaningful change in the management regime, based on causal links. In some cases, however, watershed processes are dominated by different sets of causality at different times. Sedimentation, for instance, may be dominated by human actions most years, but cumulatively dominated by rare, extreme natural events. Under these conditions, it may be extremely difficult to develop prescriptions since much of the research effort will be spent on distinguishing "natural" from "human-caused" events. Similarly, data from one year cannot be assumed to be representative of "average" processes. Processes that are predominant during most sampling periods may not dominate the long-term physical balance.

Long-term phenomena can most usefully be addressed with baseline studies that look for trends and with short-term studies tied directly to management actions. Sedimentation may be observed with "synoptic" studies that identify sources by looking in many places at the same time. Determining whether those rates are actually low or high would require a long-term study, which is useful research for understanding the ecosystem, but too lengthy for immediate management prescriptions.

Inventories of processes must reflect the time spans associated with those processes. A sampling scheme must consider both incremental and catastrophic alterations to the environment. Assessments must recognize the difference between average and dominant change, avoiding both reliance on extrapolations of short-term catastrophic data and underestimations of impact determined by incremental phenomena. In practice, this means that watershed research must be both long- and short-term and that managers must be willing to commit to studies of both catastrophic processes and incremental trends. Research funding must recognize this need as well, and encourage both baseline and goal-oriented studies.

### *5.3.3. Access*

Watershed assessments, perhaps more than other resource inventories, are dependent on good access to large areas. Watersheds frequently have multiple owners, multiple management goals, and a range of resource activities. The most extensive activities usually occur in headwater areas while the most intensive activities occur in the lowlands. For example, the Willamette basin has forestry, range, and wilderness activities in the headwaters of the eastern Coast Range and the western Cascades; it has a broad belt of agriculture with scattered towns on the alluvial plain; and it meets the Columbia at Portland in an urban area. Each activity has different owners, with varying goals and sensitivities about providing access to watershed managers, researchers and the public.

Access is a reflection of the area included within the assessment. Analysis of large scale landscape phenomena, such as cumulative watershed effects, demand assessment of off-site impacts. This level of survey is termed "watershed" or "basin level" in the FEMAT report, and "*Level 1*" within the TFW protocols. Analysis of processes, impacts and effects requires thousands of acres because the long-term, episodic nature of watershed phenomena must be documented over long periods and large areas for process rates to be measured and for predictions to be meaningful.

Some assessment systems are more dependent than others on access. In-stream sediment sampling can generally be done from a public roadway, off a bridge in the lower portions of a stream. Fish sampling, however, requires good access and permission. Evaluation of roads requires access and a working relationship with the road owners. Wildlife sampling or sediment budgets may require good, all season, all hour access to limited areas, identified from maps or photos.

Targeting techniques and synoptic measurements are most dependent on good access. Targeting is generally done for critical site analysis. Targeting requires extensive ground checking of photos coupled with overland hiking to trace problems to their sources. Similarly, synoptic measurements require extensive simultaneous access to very specific points throughout the headwaters of a watershed.

Modeling methods are the least dependent on access, though they, too, require field data and ground checking. Some models are meant to be used with relatively little field data, such as the regression models and probability approaches which assume reactions similar to those measured under controlled conditions. Expert systems, on the other hand, are clearly dependent on field visits.

The ability to gain access can be the critical element of a watershed inventory. In practice, the critical "place to be" will always be just across the fence from easy access, but this should not defeat the watershed analysis. Good relationships among all parties involved in the watershed ease the assessment process. In addition, watershed researchers depend upon each other to maintain good relations with the people of the watershed. Access is made easier when the participants are honest, courteous, and share questions and results.

### *5.3.4. Baselines in Time or Space*

Implicit in impact assessments is a comparison to "normal" conditions. This comparison is frequently very difficult to make, because the parameters that the manager wishes to compare were not specifically measured in the past. Even in cases of the most obvious impact, for example where a dam has stopped a salmon run, it is nearly impossible to find or reconstruct data from the past with the accuracy of present-day data. This puts the assessor in a difficult position. Management recommendations must respond to a set of real conditions, but a lack of historical data prevents an accurate assessment of change.

Predicting the future effects of current changes is similarly hampered by lack of data. Each watershed is unique, and projecting future impacts of management changes may be most accurate when based on the watershed's responses to impacts in the past. Without accurate records, impact prediction becomes guesswork.

Several assessment approaches are used to overcome the lack of baseline data. Space can be substituted for time, one can use the protocols of the past, or one can use past data sets as indicators of conditions. Each of these methods suggests that monitoring should be conducted under strict protocols and directed towards resources of present and future concern to create a useful record of today's conditions for future watershed assessors.

Substituting time for space means using a present-day watershed that is similar to a watershed in the past, in order to understand those past conditions. This is often possible for small watersheds. Forest Service Research Natural Areas are specifically kept in "baseline" condition, as are many areas in state parks, National Parks, Bureau of Land Management Areas of Critical Environmental Concern, U.S. Fish and Wildlife Service refuges, and private and non-governmental preserves. These areas are relatively small, may not presently keep records, or may be strongly affected by management practices in the past and preserved for restoration purposes. In many cases, however, for a clearer view of the watershed's past, it is useful to see if "reserve" areas physically similar to the study site are available.

The ecoystem concept (Hughes and Larson, 1988) is a spatial framework for assessing and managing regions that have similar variations in selected environmental characteristics. It is neither possible to manage on a site-specific basis, nor desirable to manage on a national basis. Ecoregions group naturally similar ecosystems, and hence stratify the parameters of interest (for example, water chemistry or biota). These regions have similar ecological potentials and hence can be managed in a similar way. The attainable environmental quality for a region is based on an assessment of conditions in minimally impacted reference sites within the ecoregion. An evaluation by EPA (EPA, 1991b) concluded that classification into ecoregions was a valid and useful tool in management for water quality.

The need for good ecologic, hydrologic, and geomorphic data from undisturbed and recovering areas will increase in the future, as state and federal agencies implement biodiversity programs. Representative data from specific ecosystems will become part of "desired future condition" parameters, in an effort to balance resource production and biodiversity goals. While searching for baselines as part of a watershed assessment, one should look to local and national biodiversity organizations for local sites; these may not be identified as research or protected areas, may not be watersheds, but may add significant baseline data to the watershed assessment effort.

If a reserve area shares characteristics with the study watershed, a number of questions may be answered. What are its fisheries like? How does it respond to sediment? What are its stream channels like? For a given impact assessment system in an undisturbed area, how much "natural" impact is apparent? How are undisturbed areas significantly different from the "disturbed" area? Which sampling protocols can be used on both the baseline site and the study site for assessment into the future?

Sticking to the protocols of the past is a useful but limited tool for assessments of large areas in relatively short time frames. One can use previous relevant to the study's goals, and then re-sample the site using the same methods used in the past. This system allows direct comparison to past records in order to show real change. Examples are comparisons of aerial photos, ground photos, maps, water records, mining data, stream cross-sections, forest inventories, hunting and fishing accounts, and engineering surveys for dams, pipelines, or roads. The limitations of this approach are: specific data sets may have little bearing on the present perceived problem, data collected in the past do not necessarily meet today's quality assurance standards, and rates of change cannot be determined with only two data points.

Past data are most useful when collected often, carefully, and for a specific purpose. This creates a data set that may be compared directly, without variation in resolution, error, or area. A good example of this is map comparison to determine river changes in a floodplain. Maps were made regularly for reappraisal of property lines, with good resolution and at frequent intervals. Overlaying current maps with maps of the past illustrates changes and rates of change in the stream's shape, course, overall gradient, and perhaps riparian zone.

Managers can best use past data sets as indicators of conditions if they are categorically aware that indicators describe trends, not reality. Fish harvest, for instance, is an indicator of fish population, but not linked to population in a causal manner. Total fish abundance is one factor, but so are the fishing effort, fishing technique, and the methods and biases of the original data collection. Indicators can be useful if their limitations are acknowledged and the goals of inquiry stay the same as in the past.

### *5.3.5. Funding the Measurements*

Research includes scoping, literature review, testing of survey instruments, statistical assessment of a sampling method to assure robust results, diligence of trained crews, good data analysis, careful write-up, and publication. Many studies may be too ambitious, encompassing more than available resources allow.

Planning a study requires development of a budget that will support data collection, analysis, and publication. Many studies end in masses of data collected, sitting in drawers, unanalyzed. Good planning is economic planning, within the constraints of the institution, with solid commitment to complete the entire research process.

Time is one monetary constraint, effort is another. Sampling studies vary in their requirements for field time, equipment, sample analysis, laboratory expenditure, and expert consultation. The key to understanding potential costs lies in sample design and in the number of samples necessary for analysis. Water samples, for instance, may be so variable that a study requires many samples, possibly increasing the expense beyond the study's usefulness. A biologic indicator for the same parameters may have less variability, thus requiring fewer samples for the same degree of certainty; the trade-off would be in the causal link between the measured value and the impact for which it is a surrogate.

Other inventory methods require high capital outlay, but are statistically robust elements of a long-term monitoring program. Geographic information systems (GIS) can accommodate many sampling methods after initial start-up costs are met. Stream stations or weather stations have high start-up costs, but will generate relatively low cost, very high quality data for many years. The statistical strength of such data will be greater than single samples because data collection followed robust, long-term protocols.

Another cost lies in getting to field sites. In many instances, the greatest cost of a study will be the field time, including per diem and travel time required to reach each site. Many studies and inventories accommodate this expense by sampling many elements at each site. If it takes a day to reach a plot, then it is important to get as much data as possible per plot. This can lead to collection of irrelevant data or data for which there is no reduction scheme. Adhering to established protocols that are part of a data reduction process reduces this loss of time and money.

Money or institutional commitment thus becomes a dominant constraint to research. In watershed assessments, field research in which teams of trained people go to many places over time may be the most expensive component. Models, using previously collected data, may be the most cost efficient. Stream sampling, with repeat visits to a specific site where impacts concentrate, is a mid-cost approach.

### *5.3.6. Number and Skills of Workers*

The skill level of workers determines the amount of oversight required in the field, the level of training needed, and the salary cost per day. Some assessment methods such as GIS, stream insect identification, or geologic and soil investigations require individuals with specialized skills. Other techniques rely less on skills and more on repetitive investigations, such as measurement of stream features, road investigations, or logging and agricultural surveys. The experience of a senior researcher may be required to establish monitoring sites or to negotiate access to private lands. The complexity of the task alone does not determine the ability needed for field work.

Relatively complicated sampling at one station, such as stream sampling for suspended sediment, may benefit from a group of skilled workers who effectively repeat a protocol. Some research is highly dependent on worker interpretation, such as keying aquatic insects to the family, species, or subspecies. In those cases, it may be critical to have one worker or a closely associated set of workers conducting the research, to reduce "non-sample error" in the analysis.

The need to have data over several seasons also demands continuity and cross training among personnel. Stream temperatures over a year, for example, are not comparable if samples are taken using different protocols. Much of the initial development of watershed assessment protocols must address documentation of procedures, field identification of sites for revisits, and training workers to know both the local systems and develop useful alternatives when those systems become impossible. It is important to recognize the large cost of getting the researcher to the site, so personnel must maximize the value of each field visit.

Skills that are most commonly associated with watershed assessment range from the physical sciences to computer skills to biological sciences to social sciences. When putting together a scoping team, consider the following specialties:

| *Physical Science* | *Biological Science* | *Social Science* | *Computer Science* |
|---|---|---|---|
| - hydrology | - botany | - economics | - GIS |
| - geomorphology | - forestry | - sociology | - statistics |
| - civil engineering | - range ecology | - human ecology | - sampling |
| - water quality engineering | - fisheries biology | - meeting facilitation | |
| | - aquatic entomology | - environmental planning | |
| | - soil science | | |

## 5.4. Using the Assessment

A distinction in responsibility is made between measurement of effects and decisions on significance. The proper use of science is in measurements and in the analysis of alternatives. Blurring of measurement and decision is one of the weaknesses of various aggregated indexes.

Evaluation of significance is part of the problem identification process in recent assessment methods. The expert systems approach to identifying problems, and to determining cause and effect relationships contain evaluations of significance. It is generally agreed that evaluation of significance should not be left entirely to the experts. A public participation stage must be built into the process to bring public values into the consideration (Thompson, 1990).

A cumulative watershed assessment procedure needs an amount of detail necessary for a particular problem in the particular watershed. This need is one reason for an initial level of screening. However, a potential weakness in using the assessment is that the initial screen can miss subtle but significant problems. The screen, therefore, must respond to very specific questions to prevent a superficial evaluation at the first level. A second critical need is for standards to be set at a level that provides adequate protection.

A question often arising in decisions based on watershed assessment is what to do when there is not enough information for good decision-making. One approach is to be conservative and give the benefit of the doubt to natural processes, favoring evidence showing disturbance by potential activities. Another approach is to wait and see what the results of the potential activities will be. Adaptive management allows changes in the implementation of a plan when new information becomes available.

# 6. WATERSHED ASSESSMENT SYSTEMS: CATEGORIES AND EXAMPLES

Reid (1991) and Megahan (1992a) evaluated different methods used for cumulative watershed effects analysis. Euphrat (1992) compared different methods in the field. Each of these reviews found that different watershed assessment systems are appropriate for assessing conditions for different beneficial uses because of the different time scales, areas, and physical processes that determine these uses. Categories of assessment systems help define needs for evaluating the state of the resource, the mechanisms of pollution, and the implementable solutions.

This section focuses on the categories shown in Figure 3, initially distinguishing between inventories and models. Inventories have been grouped by their survey objectives: streams, physical watershed elements, and mixed surveys. Models are distinguished according to their form of modeling: expert opinion, statistical relation, physical modeling, and probability. Choosing among these forms enables inventory and model users to choose appropriate methods to fit present needs and define future management tools.

Cumulative effects analysis is frequently a combination of an inventory and expert opinion. It takes this form because NEPA asks for the impact of a project and its cumulative effects when combined with past projects (inventory) and with foreseeable future projects (expert opinion). One must evaluate the state of the resource in order to predict the impact of the proposed project and other future projects on beneficial uses.

A complete watershed assessment system includes an inventory method and an analysis. Megahan (1992a) grouped methods for cumulative watershed effects assessment on the basis of watershed processes. He identified tiers in the watershed assessment process, with an initial screening for scoping and targeting, followed by a detailed assessment of watershed processes and physical responses. Most of the methods Megahan reviewed concerned physical characteristics such as erosion, sediment yield, and channel condition, and analysis was geared towards a prediction of geomorphic responses to impacts from logging. Other watershed analyses, for other goals, will probably take a similar form:

1) Problem identification: some beneficial use has been degraded to the point where restoration is desired.
2) Scoping: a quick inventory shows where critical areas of degradation exist, and initial assessment proposes links to land management activities.
3) Inventory: a detailed inventory focuses on the likely source areas and looks for causal links to the degradation.
4) Analysis: with the addition of geographical, statistical, and scientific information, the hypotheses can be tested.
5) Prediction: following confirmation or denial of the causal links between management and degradation, and investigation of other processes found during inventory and analysis, analysts predict the impacts of proposed projects.
6) Monitoring: after prediction of watershed responses and implementation of management, watershed characteristics are monitored to validate or disprove the predictions based on the analysis.

The survey by Megahan indicated that scoping and inventory should be used together for maximum effectiveness. Scoping may consider all possible cumulative watershed effects, evaluate the hazards and risks, and provide an indication of the causal links between land use and downstream effects. Increasingly detailed analyses further define the nature of these links and necessary impact reduction strategies.

Approaches for watershed assessment should be selected on the basis of short- and long-term goals. Broad regional differences in physical processes should be stratified to provide a starting point for the scoping process and to focus the analysis on specific resources. A checklist such as the "criteria" questions in Table 3 should be used to screen needs and watershed assessment systems. These questions are a starting point, and should be elaborated for specific assessments. A Socratic approach to assessment through responses to "critical questions" is intrinsic to the TFW Assessment method as well, clustering relevant questions within specific assessment modules (WFPB 1994). Framing the assessment as a set of questions allows the inquiry to be goal oriented, to reflect issues raised by experts, and to be tailored to the individual site. A common set of questions also allows the watershed assessment group to clarify its goals and constraints.

Many watershed assessment methods have been used only by their authors, as applications to specific problems. These methods often come from research groups and are directed at specific problems. Much of the documentation is in journals. These methods are primarily research efforts to increase understanding of the functions and relationships in watershed ecosystems. Land management and regulatory agencies have attempted to standardize methods and test them under a range of conditions. Watershed assessments are now "standardized" within some divisions of the U.S. Forest Service and state forestry agencies for cumulative watershed effects, and the EPA for wetlands assessment. Other "standardized" methods have been proposed for agricultural and range watersheds.

**Table 3. Screening Questions for Watershed Assessment Selection**

| | |
|---|---|
| 1. | Which beneficial uses of water and/or the watershed does the method consider? |
| 2. | Does the method involve all affected parties? |
| 3. | What is the public's role in the assessment? |
| 4. | Does the method identify watershed processes and lead to understanding of causal links? |
| 5. | Does the method incorporate the spatial and temporal variability in the watershed? |
| 6. | Can the results of the assessment by this method be used to make management changes? |
| 7. | Does the method evaluate the risk to beneficial uses from impacts? |
| 8. | Does the method assess the resilience of the landscape? |
| 9. | Does the method identify biological diversity and existing watershed resources? |
| 10. | Does the method identify the "best watersheds" or the watersheds closest to their potential, which can be used for future baselines or reference sites? |
| 11. | Is the method restricted to a particular region or land use? |
| 12. | Has the method been validated using independent data? |
| 13. | What tools must be available to use this method? |
| 14. | How much work will data collection and analysis require? |
| 15. | How many seasons are necessary for repeated field measurements? |
| 16. | What technical skills are required for the analysis? |
| 17. | What skills will be required of personnel for the different phases of the research, analysis, and write-up? |
| 18. | What are the initial and continuing costs of the assessment? |

## 6.1. Inventory Methods

A watershed inventory determines the condition of a watershed, can provide information on its processes, and can predict its ability to yield beneficial uses. If the watershed's processes are limited by environmental factors such as temperature, geology, or human impacts, a watershed inventory can identify the most critically affected resources and sites for potential improvement. Though still far from offering a perfect description of watershed processes, watershed inventories are an excellent tool for improving assessors" understanding of the resource.

Watershed inventories are management tools designed to gain information and identify thresholds for management decisions. The most simple inventories measure specific physical features such as water quality, tree volume, or road mileage. Inventories are more complex when they include biologic or geomorphic features, such as in-stream samples of fish or insects, mapping of ecological units, or delineating and dating landslides and in-stream sediment. Each measurement requires the judgment of experienced researchers. Several watershed assessment inventories now being developed attempt to include specific measurements for elements that have been measured subjectively in the past.

Many inventory methods are described in detail in MacDonald et al. (1991) Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. This document is available with a computer program (PASSSFA) that can be used to choose inventory methods based on the perceived problem and the limitations of time, money, and technical expertise. This publication also gives relative values for the cross-correlation between different parameters of water constituents, stream features, and aquatic and riparian biota in response to silvicultural impacts.

### *6.1.1. Water Column*

A common method of watershed condition assessment is water sample analysis. This method focuses on pollutants dissolved or suspended in the water. Protocols are well established for water chemistry, temperature, turbidity, dissolved oxygen, biological oxygen demand, and bacterial pollution. The choice of parameters and protocols depends on the beneficial uses for the water in the stream and on the presumed contaminants that may indirectly affect those uses.

Use of water sample analysis assumes that the water column integrates the range of actions in the watershed. There are obvious limitations to this assumption, as flows and land uses change with season and weather. Specific parameters vary during the year. For instance, sampling for sediment in the water column is best done during high flows; sampling for metal concentrations is best done at the times when sources are contributing directly; and sampling for bacteria is best done either at low flows, when pollution is not diluted, or during storms, when rivers receive runoff directly. For all pollutants which affect beneficial uses, it is important to know both the peak and the range of concentrations.

Beneficial uses may not have a strong causal link to water quality parameters. Temperature and dissolved oxygen are important for anadromous fish habitat, for instance, but generalization across the stream's geography and the fish's life cycle are not possible. While many water column constituents may be measured in any given sample, the timing of sample collection, the statistical frame of the sample, the history of sampling, and the interpretation of the results will determine the usefulness of the data as an indicator of watershed conditions.

Lake assessment is generally limited to water column sampling. An excellent reference for lake methods is the EPA's Volunteer Lake Monitoring: A Methods Manual (Simpson, 1991). This handbook ties specific methods for sediment, algae, nutrients, oxygen, acidification, and bacteria to citizen access and involvement opportunities.

Specific water sampling methods may also be found in the series Standard Methods for the Examination of Water and Wastewater, published by the American Public Health Association (1985). Protocols are also available from specific state water quality agencies and the U.S. Geological Survey (USGS). It is particularly important to follow protocols for water column sampling because the results can then be compared with legal definitions of water quality.

The next sections describe several parameters measured in the water column.

**a) Sediment**

Sediment is often the NPS pollutant of greatest concern. Sediment comes from many sources: agriculture, forestry, road surfaces, construction, off-road vehicle use, mining, urban activities, and erosion by the stream of its bed and banks. Because of the variety of sources which produce it, sediment is often a result of cumulative effects in the watershed. When sediment begins to significantly change the stream channel, it may signal that the watershed's cumulative effects have crossed a threshold, from simple additive effects to synergistic effects.

Interpretation of the amounts of sediment found in the water column can be an effective way of assessing upstream impacts. In addition to measuring the results of a range of activities, in-stream sampling may be done far from the source, on lands with good access, and in relatively safe conditions. Suspended sediment sampling can also be used for remote sites or sites without access. Field and laboratory work is relatively inexpensive. Samples can be taken from a series of storms (one point, many times), or from the entire watershed in a synoptic approach (many points, one time).

Hand sampling methods allow the researcher to assure that the sample was collected well, an advantage over automatic samplers in small streams. Automatic samplers can take samples integrated through the water column at intervals proportional to flow, and therefore, to transport of sediment. Thomas (1991) presents approaches to automated sampling and improving its accuracy. Edwards and Glisson (1988) give standard field methods developed by the USGS.

### b) Turbidity

Turbidity, the opacity of the water measured by its capacity to block light, is a useful measure for assessing watersheds. Turbidity is linked to the production of fine sediments from a watershed and has a direct impact on the beneficial uses of water. Clarity of water is an important quality of drinking and recreational waters, is biologically important to fish for sighting prey, and is a limiting factor to aquatic plants which receive light through the water column.

Turbidity may be measured on water column samples. Because the finest material creates the water's opacity, samples do not necessarily require integration across the flow. Turbidity is easy to measure, but does not relate directly to suspended sediment. Relative turbidity-suspended sediment relationships vary from watershed to watershed, season to season, and within a storm itself. Turbidity, however, becomes a useful measure of sediment transport when calibrated to processes within a given watershed (Beschta, 1983).

### c) Pesticides and Petroleum Products

Herbicides and pesticides may enter waters from forestry, agricultural, or urban sites. Petroleum products, particularly oil, gasoline and solvents, are pollutants generally associated with urban areas. Diesel fuel and other oil-based agents may be mixed with pesticides as an "inert" carrier for application on forests or agricultural crops.

These chemicals may be assessed in water column samples. Unlike sediment, however, their peak concentrations will not be a function of flow but rather of time and method of application, rainfall, and irrigation. This makes the usefulness of a single point-in-time, point-in-space sample dependent on timing and access. Testing for herbicides entering streams from aerial forest applications, for instance, is done on-site during the spraying.

Chemical analysis for these pollutants may cost hundreds of dollars and require several weeks. Concentrations of specific compounds will not give information on the interaction or cumulative effects of the compounds on biota. Direct biological testing using insects, fish, or other bioassay procedures may be a more effective method to determine the watershed impacts of chemical pollution. These methods are discussed under 6.1.2(c), Biological Assessments.

### d) Nutrients and Pathogens

These common watershed pollutants are normally tested by water column analysis. Sources include septic system leaching, broken sewer systems, grazing, feedlots, agriculture, and wildlife. Pathogens reduce water quality by their effect on consumers; nutrients reduce water quality by fertilizing algae populations which reduce available oxygen, decrease available light, and strongly modify the stream habitat.

The evaluation of the nutrient load of a stream or lake should not be limited to water column sampling. The nutrient response should be apparent in algal levels and in the mix and diversity of fish and insect species. Pathogens may also result in changes within biological populations. Nonetheless, our overwhelming societal concern over water quality for drinking, fishing, and contact recreation will continue to demand evaluating pathogens by laboratory analysis of water samples.

### *6.1.2. Stream Channel Features*

A second group of inventory methods measures the physical and biological characteristics of stream channels. These methods concentrate on stream cross-sections, sediment storage, bank stability, amount and placement of large woody debris, and the arrangement of vegetation in and over the channel. These components are often difficult to measure and they change with events in the watershed. Stream features are strongly related to beneficial uses, however, particularly to fish habitat in the Northwest. The bed and banks of streams are also useful predictors of future conditions; sediment, vegetation, and flow are interrelated, and severe impacts may deepen and prolong the effects through positive feedback mechanisms.

The most common approaches to stream assessments are categorization, checklists, insect and fish sampling, and indexes. Repeated assessment of the same stream under the same conditions will show the changes taking place. These methods require managers to go into the stream channel, to conduct "open-eye and open-minded monitoring" (MacDonald and Smart, 1992). A good watershed assessment requires the researchers to familiarize themselves with the stream, its watershed, its condition, and is uses.

**a) Categorization**

A stream may be evaluated section by section, or reach by reach, to give managers an idea of its value for fishery production, geologic stability, or flooding potential. During the last ten years, state and federal agencies have conducted many stream surveys. Typically, a group of technically-trained people walk the stream and note characteristics of the channel and habitat. The surveys use categories or checklists.

Statistically, stream segments are highly variable. Each segment has a different watershed area and cumulative history. Many measurements and many hours of analysis are necessary to obtain meaningful information. The costs of these surveys are relatively high and a crew can complete only a limited number of miles of stream during a field season. Individual biases (non-sample error) may also affect results because different people see and describe the same scene differently.

The Hankin and Reeves (1988) stream inventory is a good example of a survey approach for fisheries. It uses "calibrated ocular estimation" of cobble embeddedness and other stream channel features. Crews are hired for the summer and trained for the specific observations required for these estimates. The method yields fairly specific descriptions of stream segments. The disadvantage is the lack of a connection between the observations and possible management decisions.

A commonly used survey method that focuses on the physical characteristics of streams (Rosgen, 1985) categorizes streams according to stream gradient, sinuosity, width/depth ratio, channel materials, entrenchment, confinement, and soil/landform features. The Rosgen surveys include information on debris flow and vegetation. The observations are useful in developing an overall assessment of a stream or a set of streams relative to each other.

While the Rosgen approach develops physical data for streams, the Pacific Rivers Council (1992) has developed a watershed assessment system based on biological data, or ecosystem functions, as part of a restoration strategy. This inventory concentrates on finding ecologically diverse and relatively undamaged watersheds. The inventory identifies watershed refugia and downstream habitats critical to existing populations. These "good sites" are evaluated for corridor creation within the stream network. The strategy was devised for protection of salmon, but could be expanded to other plants and animals. The Council sees watershed resource evaluation and restoration as part of a legal framework for management policies on public or private land.

Each of these methods categorizes streams in terms of potential habitat for fisheries, either directly or indirectly. They yield what is essentially a map of problem areas, restoration opportunities, and "good" habitat. These methods are useful as site-specific scoping tools.

**b) Checklists**

Checklists have been developed to reduce arbitrariness in the assessment of forest streams. Two important checklists are the Forest Service Northern Region (1975) (also called the Pfankuch) method and the California State Department of Forestry's "Addendum 2" to the Forest Practice Rules (1991). Both stress the physical stability of small steam channels, focusing on second order streams. Both methods list criteria so that researchers may "rate" the channel, resulting in a value between Excellent and Poor. These checklists are good ways to look at headwater streams, but the user must be cautious when interpreting the results. The checklists are designed around a specific environment, so may have hidden biases towards a particular notion of a "healthy" stream.

Checklists that have scores do so by giving weights to different stream conditions. These weights may introduce significant biases into results by over-representing some features at the expense of others. Thus, as with categorization, checklists are best used repeatedly in a specific geographic area.

Checklists are relatively repeatable and are designed to be used by people from a broad range of disciplines. They demand a hard look at stream features which may have previously gone unnoticed. Checklists indicate where erosion or scour problems are occurring in the watershed but do not link those features to probable causes.

**c) Biological Assessments**

Biological stream assessment methods are based on the idea that the biota itself is the best integrated measure of habitat quality. As stated by Brooks et al. (1991):

> The primary advantage of biological indicators is that they presumably integrate the impacts of water pollution over time. This continuous record typically is not available from chemical sampling protocols. Whereas chemical parameters have proved useful for monitoring point source discharges into surface waters, biological and physical measurements appear to be better for assessing the effects of more dispersed impacts such as non-point source runoff, incremental losses of wetlands, and changes in land use along riparian corridors and throughout watersheds.

Counts of individuals and species of fish or larval insects can help characterize stream productivity or relative degradation. Biological methods that measure other forms of biota or other measures of the biotic community, for example quantifying plankton, algae, riparian or aquatic plants, may be similarly useful in larger streams. All these approaches consider the flora and fauna of the steam to be indicators of watershed health. As with other methods, biological sampling does not indicate why problems are occurring, only the severity of the impact.

Merritt et al. (1984) give an excellent introduction to biotic stream sampling techniques, including equipment and sampling problems. Interpreting the response of insect populations to silviculture, agriculture, and urbanization is addressed in Erman et al. (1977), Dance and Hynes (1980), and Jones and Clark (1988), respectively. The small number of samples relative to the variability of the steam and its biota is a difficult problem which these papers address.

Fish are an extremely useful biological indicator of watershed health because they directly represent a beneficial use of the stream. A major drawback with anadromous fish sampling, however, is distinguishing between in-watershed and out-of-watershed impacts. Also, sampling is difficult and can cause physiological stress to the fish. Methods of fish counting include trapping during migration, counting returnees to a hatchery, electrofishing, and counting by observation.

Two standardized methods for combining fish and other biological data are the Ohio EPA Biological Criteria Program and the Index of Biotic Integrity, also from Ohio. The Biological Criteria Program developed numerical "biocriteria" for each of the ecological regions in the state by using fish and macroinvertebrate data from more than 300 "least impacted" state reference sites (Yoder, 1991). These biocriteria have been incorporated into the state water quality standards. Through examination of biological and chemical data, habitat analysis, and source information, an effort was made to diagnose the probable causes and sources of impairment. The Ohio EPA has learned through experience that some patterns among indices correspond to particular impact types and they are developing these "biological response signatures" to assist with the identification of impact sources.

The purpose of the Biologic Criteria Program is to assess water body condition, and diagnose probable causes and sources of water use impairment. The method utilizes biological information in multivariate indices (for fish, aquatic invertebrates, and habitat) to reveal patterns of biological community response. Target values for each index are determined by sampling at a reference site, which is in a reasonably pristine area of that ecoregion. Sampling is done over time at specific locations through the ecoregion to determine if the sites are attaining the legally defined biocriteria scores and to identify patterns of response that may indicate impacts and their sources.

This assessment process is a pragmatic, simple approach that has great merit provided natural variation due to biogeographic and other site-specific factors are taken into account. The data-rich approach can provide confidence in interpreting the nature of ecological stress, but it does not yield stream segment-scale variation data. Regional studies would be required to adapt this system to the Pacific Northwest.

The Index of Biotic Integrity was developed to assess the biological integrity of streams (Karr et al., 1986). It integrates 12 attributes (*metrics*) of stream fish assemblages that together indicate the biotic integrity of the stream. Metrics fall into three broad categories: species composition, trophic composition (feeding strategy), and fish abundance and condition. The value of each metric is compared to the value estimated from sites located in a similar geographic region on streams of similar size having minimal human disturbance. The sum of the 12 ratings yields an overall site score. This index requires regional tailoring by experienced biologists and physical scientists (Miller et al., 1988).

**d) Physical Stream Indexes**

In searching for a strong connection between fish habitat and physical features, some researchers have chosen to measure very specific stream characteristics as indexes of stream quality. Lisle has suggested that impact may be measured by the degree of pool filling in small streams or the quantitative measure of sediment in gravels (Lisle, 1987; Lisle and Eads, 1991). Other characteristics of the physical stream can be quantified, such as cross-sectional changes of the bed, particle size of the bars and riffles, pool-riffle ratio, sinuosity, or width of the stream channel or riparian vegetation zone. These are the individual characteristics which, when combined, develop an approach similar to the categorization system spelled out by Rosgen (1985). Grant (1988) suggests using photographs to measure changes in stream canopy, and from that, assess changes in flow regimes and their impacts on the stream.

Flow changes are a useful index of stream response. The input/output ratio of rainfall to runoff over the course of a storm, a season, or over decades, may be measurable, significant, and indicative of accompanying ecosystem changes (Harr et al., 1975; Euphrat, 1992).

The advantage of physical stream measurements is that they are more statistically robust than other methods. They are better able to test the significance of assumed relationships. They are more closely connected to on-the-ground practices than other methods because they measure features that are associated with impacts. The challenge remains to find or create indexes of physical features that relate directly to biological productivity. The existing methods appear to provide a good mid-level of assessment; they are relatively quick, inexpensive, and easy to apply and interpret for a given watershed.

### *6.1.3. Watershed Land, Vegetation, Biota, and Habitat Inventories*

The simplest inventories are tallies of specific features within a watershed. From such tallies one can calculate the total length of road miles, the total acreage of farm, forest, urban areas, or the condition of a specific land-based resource like old-growth forests. The tallies may be done from maps or photos. The data may be displayed on overlays or geographic information systems (GIS) and be addressed in a sophisticated fashion through logical queries. The quality of the data improves with more "ground truth," increased resolution, and diverse historical sources of data.

Inventories of watershed features can provide useful answers to practical questions. How many streams are crossed by unimproved roads within a watershed area? What is the original and present condition of the watershed's vegetation? Who owns the old-growth forests? Where is the potential goshawk habitat? What watersheds comprise the present deer wintering range? How many acres of a farming watershed will need nematicide this year? What is the expected pesticide application in this watershed? Where will urban discharge of oil and grease be a problem?

Obviously, the quality of the answers will depend on the quality of the data. GIS displays are being developed by many counties, states, federal agencies, non-governmental agencies, and corporate landowners. Consultants are putting together systems to yield information for their clients. Several agencies are creating systems to collate information and to develop access to that information. Watershed assessors should check with the parties that manage lands within and adjacent to their area of interest; a GIS with some inventory elements may already exist.

One common physical watershed inventory method tied to management of forest lands is the USFS Equivalent Roaded Area (ERA) system (Haskins, 1983). This method gives specific impact values and decay factors to land management practices and assumes that roads are permanent features. It is not tied to watershed processes, however, though it has been used as a threshold indicator. Because ERA is not causally linked to pollution, it is better used as an index of disturbance than as a cumulative effects predictor.

A sediment budget is a causally-based inventory for assessing sedimentation sources. Different watershed features such as roads or landslides have different erosion rates and different rates of sediment transmission to the stream system. Soil types and land management are also strata which differentiate erosion rates. Sediment budgets are useful because they can provide the "big picture" in assessing individual source areas in large watersheds over long time scales. Excellent references on sediment budgets are available, notably Dietrich et al. (1982).

Other inventory methods useful for determining watershed condition or impacts are soil surveys, timber inventories, wildlife surveys, topographic and geologic maps, and special use maps created for the assessment of a particular feature. Photographs may also be useful for determining landslide frequencies, riparian cover, and drought, wind, or insect damage. In short, combining available information may give researchers a good picture of watershed condition. Inventories may be used for planning or assessment of the watershed. They may also be coupled with stream or feature-specific data to create a mixed-method analysis for predication of watershed conditions.

Using existing watershed inventories is relatively inexpensive when data have already been collected for different purposes. Inventories can give a historical base to impact assessment. Spatial data can be entered into a GIS to make scales match, to point out data gaps and discrepancies, and to conduct tabulations and queries. GIS is a useful tool for watershed analysis, allowing assessors to create new layers of information by overlaying, weighting, or otherwise manipulating existing data. From a GIS, researchers may also develop planning model inputs to predict growth of timber, yield of sediment, access.

The Watershed Classification/Aquatic Biodiversity Subcommittee of the Oregon Chapter of the American Fisheries Society (AFS) convened in 1990 to address concerns about the rapid decline of native aquatic species in the Pacific Northwest. Their Biodiversity

Strategy is the result (Bottom, 1991). Their intent was to develop protocols to identify aquatic ecosystems, communities, and populations that are in the most immediate need of protection or restoration. The first phase of the Strategy identifies critical aquatic habitat areas in Oregon where protection, management, or restoration can serve immediate fish biodiversity objectives: (1) locations where native fauna are at immediate risk or sensitive to future disturbances, (2) relatively unaltered watersheds that represent the best remaining examples of native aquatic ecosystems, and (3) connecting corridors that provide essential links between healthy populations. The AFS would compile the information and draw maps to target biodiversity protection and restoration efforts. This method represents a quick approach to identifying sites in a large region in order to develop priorities for protection and restoration. The process is entirely an expert system inventory. It may provide a good idea of where the "best of the last" ecosystems remain and where extensive degradation has eliminated all natural habitat and/or biotic communities. This method is not recommended as an alternative to a more focused, basin-specific assessment.

Croonquist and Brooks (1991) proposed another ecological watershed inventory, using avian and mammalian guilds as measures of watershed biodiversity. Their purpose was to assess impacts to a landscape using bird and mammal communities in riparian-wetland areas as cumulative effects indicators, and to provide a more efficient environmental impact assessment technique than a single-species approach. The interest in the response of wildlife communities to watershed disturbances arose from the need to determine the feasibility of wetlands restoration efforts.

Avian and mammalian guild inventories use information that reflects species sensitivity to disturbances, assigning species to a specific response guild. Response guilds are groups of species that respond in a similar manner to habitat perturbations. Biological monitoring of guilds is conducted in conjunction with analyses of landscape patterns to identify changes in the functional characteristics of wildlife communities in response to habitat changes. Guilds are based on habitat requirements, and can serve as a screening tool for identifying habitat condition or determining which habitat factors are important in management decisions. An understanding of how groups of species respond to environmental impacts can illustrate what aspects of the habitat must be restored in order for guilds to recolonize an area.

The avian and mammalian guild response method requires good region-specific baseline data. The system is practical only for resident species since response of migratory species may reflect changes in other parts of their migratory range. The method has limited applicability because species respond differently to different impacts. The greater the range of impacts considered, the weaker the sensitivity of each response guild.

A third ecological inventory watershed approach is the Gap analysis program (GAP) (Scott et al., 1991; Davis et al., 1990). This method was developed to identify watersheds and larger areas most in need of protection of their biological resources. Gap analysis is GIS-based; it defines resource values of the habitat on-site, and also defines habitat requirements for species within a larger area. Gap analysis looks at the habitat component of watersheds. It is a strategy to manage for biodiversity, and to identify unprotected critical habitats that link two or more pools of protected habitat. Gap analysis can answer questions on how land use changes would affect biodiversity. It is an alternative to incremental attempts to save threatened and endangered species.

The Gap analysis involves identifying habitat features such as vegetation, animal species, landscape features, landownership, and climate. Vegetation is the most widely used indirect measure of biodiversity. This information is compared in digitized overlays to determine if the habitat is suitable for a range of species. It identifies the gaps in habitat for species. It also identifies whether existing protected areas can maintain biodiversity. The approach uses patterns of "species richness."

Gap analysis is a program of the U.S. Fish and Wildlife Service, being tested by cooperative Fish and Wildlife research units in 22 states. It is also being conducted by non-governmental organizations and environmental groups. Gap analysis includes some or all of the following components:

1) map existing vegetation,
2) show distributions of native animal species,
3) determine extent and importance of areas that have native species richness,
4) compare distributions of native vegetation communities with existing land uses,
5) compare places of species richness with existing land uses, and
6) provide data as part of a national biodiversity strategy.

All inventories can become part of a larger inventory data base. Land, vegetation, biota, and habitat inventories can also be used as overlays with in-channel surveys and water quality data.

### *6.1.4. Integrated Inventories*

Many watershed assessment methods take aspects of different inventory systems and combine them to meet specific assessment objectives. These methods try to overcome difficulties of scale and natural variability to develop conclusions at the local landscape level. Integrated inventories provide a landscape ecology perspective that has measures of both the physical environment and its ecological integrity.

For example, when biological evaluations are considered in conjunction with chemical and physical measurements, they may provide insight into the ecosystem's relative health and the source areas of biological degradation. The Ohio EPA method detected 50 percent more impaired waterbody segments after incorporating biological criteria into their existing chemical and physical monitoring program. This integrated approach has also been able to recognize response patterns that have been helpful in diagnosing probable causes of impacts (Yoder, 1991).

These "mixed" inventory methods combine expert opinion with measurements in order to guide the assessment process and to achieve a higher level of certainty in tracing causal links to impacts. Two important mixed inventory methods are the State of Washington's Timber, Fish and Wildlife (TFW) approach and the National Council on Air and Stream Improvement for the Pulp and Paper Industry (NCASI) cumulative effects analysis (WFPB, 1994; Megahan, 1992). Both methods are based on watershed functions and assess the impacts on cumulative effects. TFW and NCASI incorporate methodologies that account for large variability in time and space and are tailored to meet legal requirements. Both systems allow expert opinion to guide the inventory process and target the likely problem, the likely causal relationships, and the characteristics of the watershed that need to be measured in detail. Experts then interpret the results of inventories to develop management and implementation options.

Another example of a mixed method inventory is the SEAlaska Rapid Habitat Assessment (Martin et al., 1990). This approach combines a stream categorization approach with a watershed inventory and expert opinion to fill in the causal links. The process is designed to be rapid and to find local causality between stream categories and watershed conditions. The SEAlaska Corporation contracted with Pentec Environmental Consultants to conduct a study of water quality and habitat conditions of seven streams on SEAlaska land in Southeast Alaska. The study was in response to an EPA request for comments and information on inclusion or deletion of the streams from lists of waters determined to have impaired water quality. These streams had previously been classified as "impaired" based on best professional judgment but without site-specific data. The purpose of the study was to assess the quantity and quality of salmonid spawning and rearing habitat using water quality and habitat conditions as indicators. Constraints required a method using a one-time visit with no previous site data.

Water quality and habitat conditions in streams with timber harvest were categorized along a set of physical gradients. Cobble embeddedness and bank stability were used as indicators of sedimentation and turbidity; large woody debris was used to indicate channel stability and habitat quality for fish rearing. The inventory was then coupled with watershed information. This one-time comparative study of streams with divergent management histories provided data on the range and magnitude of past human impacts. The lack of natural variation as a factor in this approach, however, may create false readings in areas with a diverse natural history.

In terms of the categories used here, mixed methods such as TFW and NCASI are both inventories and models because they can incorporate predictions, implementation, and a monitoring loop for self-assessment. Coordinated Resource Management Plans (CRMP), a tool used by the BLM and the SCS largely for rangeland, are also driven by problem identification, followed by research, implementation, and further monitoring. Mixed methods are the most flexible, the most site specific, and the most responsive to local needs and expertise; they are also the most difficult to implement.

All assessments ultimately become integrated inventories when combined with people's judgments of what to measure, what is important, and where money should be spent. Committing to a subjective analysis following data collection suggests that accumulating data is not the goal of inventories; data are the basis for present decisions on research priorities and restoration needs, and predictions of future impact. As people become aware of the problems facing watersheds, they will need field work to check the quality of the inventories, to test the validity of causal assumptions, and to inject their own biases, knowledge, and experience into the watershed assessment.

## 6.2. PREDICTIVE METHODS

While inventories show what exists in a watershed, predictions suggest what may happen based on some level of expert knowledge, previously established relationships, physical laws, or probability. The distinction between inventory approaches and predictive models is important; many cumulative effects evaluations are evaluations of *what has occurred* rather than *what may occur*. The assessment of past effects and the prediction of future impacts are frequently juxtaposed in watershed assessment strategies though there is no causal connection between the two. It is important that managers and researchers know the source and the quality of their watershed evaluations.

### *6.2.1. Expert Systems*

Expert systems include both expert opinion and computer models developed to act as experts. Expert systems are the most common approach to watershed impact prediction. They give professionals a chance to incorporate their knowledge and experience in the assessment of a complicated problem without the need to justify or codify that opinion in regression-based or physics-based algorithms. This is not a deficiency, but a reasonable response to the great diversity of natural systems, human impacts, and the variety of natural processes involved in water pollution and watercourse degradation.

Expert systems start with data collection. They may be highly selective in data requirements, following protocols such as the TFW approach, or less selective and driven by the questions raised within the context of a particular watershed, as in the NCASI approach. Ultimately, the experts must respond to a question, such as the following query on cumulative effects framed by the California Department of Forestry (1991):

> Will the proposed project, as presented, in combination with the impacts of past and future projects, as identified ... and with the interactions rated ... have a reasonable potential to cause or add to significant cumulative impacts to the watershed resources?
>
> Yes (after mitigation).................................................________
>
> No (after mitigation).................................................________
>
> No (no reasonably potential significant effects)...................________

Thus, experts have to form an opinion and be prepared to offer supportive data for their judgments. No matter how clearly defined the process is, however, an expert opinion remains an opinion, including the professional or personal biases of the expert. This subjectivity of experts can be reduced through strict evaluation protocols, peer review, or significant personal responsibility or liability over the fate of the resource.

A flexible and expert-driven approach is the TFW Prototype Watershed Analysis program in the State of Washington (WFPB, 1994). TFW was developed in Washington State by timber landowners, government, and environmental and native groups for nonfederal forest lands. TFW watershed analysis is based on the assumption that fish production is directly related to the type, amount, and quality of habitat available for use and that several dominant processes (sediment production, water runoff, river–channel dynamics, and the interaction of riparian forests) determine fish habitat condition.

The method evaluates forest management impacts on fish habitat, and predicts habitat sensitivity to future management scenarios. Watershed processes and resources are inventoried to locate and map hazards, evaluate sediment delivery, and assess impacts to sensitive stream resources. The components of the model include:

1) Sediment budgets: determined by sediment sources and erosion processes.
2) Hydrology: based on precipitation intensity and duration, rain or snow events, evapotranspiration, surface and subsurface flow, and water storage in soils.
3) Riparian functions: determined by the role of vegetation in and adjacent to streams (shading and large woody debris).
4) Channel response: based on the delivery, transport, and storage of sediment and large woody debris in the channel.
5) Fish habitat: determined by a relationship between physical changes in stream morphology and suitability for fish.

Interpretation of this information allows development of location–specific analyses linking forest practices and watershed processes to effects on the resource. This approach integrates numerous physical and biological concerns. But the method begins with present conditions and does not evaluate past impacts.

Assessment modules such as those within the TFW are being designed by NCASI to clarify the process of watershed prediction with protocols. NCASI focuses on geomorphology, while the TFW approach focuses on fish habitat protection. NCASI begins upstream and looks down; TFW starts downstream and looks up. NCASI's method is intended to assess cumulative watershed effects for private landowners, aimed primarily at forestry land uses but also applicable to grazing lands (Megahan, 1992). The program is designed to develop reproducible, defensible, and accountable methods for conducting cumulative watershed effects assessments. The goal of NCASI is to implement a set of protocols for use on private lands, using a tiered approach. An initial level is a screening evaluation to assess watershed sensitivity, evaluate existing conditions, document the existence of important downstream watershed values, and define the important causal links between management actions and beneficial uses. NCASI gives special attention to the existence or risk of cumulative effects determined to be unacceptable, which cannot be controlled through management. Delineation of sensitive areas is based on regional stratification of hydrologic and geomorphic processes and local inventory data such as geologic maps, soil surveys, channel morphology descriptions, vegetation surveys, and topographic maps. A detailed analysis quantifies the linkages between resources and management. This assessment will lead to performance criteria, response thresholds, and a plan to monitor and evaluate performance. This last stage allows feedback for adaptive management. The NCASI method seeks to be cost–effective by determining the intensity of measurements within the screening procedure. Intensive quantitative measurements will be used only where required to answer specific questions.

The EPA has developed protocols for assessment of wetland ecosystems. As with the previous two methods, this EPA protocol begins and ends with expert opinion to develop prescriptions for future management and monitoring (Leibowitz et al., 1992a). The wetlands method addresses regional risk assessment and watershed planning. It identifies the effects that result from wetland impacts. The method has been tested using some hypothetical cases, for example, to provide information on the risk of valued habitat loss, and to identify habitat areas for protection as part of the development of a State Wetland Conservation Plan in Washington (Abbruzzese et al., 1990). The method was used by Gabriel (1992) to assess the status of Oregon's Willamette Valley wetlands.

The EPA Synoptic Approach to Cumulative Impact Assessment is a proposed method for evaluating the cumulative effects of individual impacts, rating priority watersheds for restoration and protection in NPS abatement programs, and assessing regional risk in watershed planning (Leibowitz et al., 1992b). It combines "best professional estimates" with "best available information." After the goals are determined, synoptic indices are chosen and landscape indicators become the basis for assessment. The results are best presented as maps of the indices. Managers can use this information to make land use decisions.

Expert systems for prediction of impact to specific environmental components will probably proliferate over the next decade. They are relatively fast and cheap, use available information, and provide understandable results. Their downfall is in their essential subjectivity. Experts, like their systems, must be accountable for developing reasonable recommendations and predictions.

### *6.2.2. Regression Methods*

In some cases, particularly for agricultural lands, there is extensive data from which to derive empirical relationships. If these relationships are statistically strong, it is possible to develop predictive models describing the relationships with simple equations or graphs. Often, a set of equations uses site specific data to yield a specific answer about the resource of concern.

The Universal Soil Loss Equation (USLE) to compute rill and sheet (interrill) erosion is an example of the regression approach (Wischmeier, 1976; Mitchell and Bubenzer, 1980). The USLE is based on 6 factors, given in the form:

$$A = R\,K\,L\,S\,C\,P$$

where A = soil loss (tons/acre)
R = rainfall-runoff erosivity factor
K = soil erodibility factor, based on texture
L = slope length factor
S = slope steepness
C = cover-management factor
P = erosion control practice factor

USLE is the basis for soil erosion prediction elements used in regression-based watershed models. USLE is limited to one watershed element or one eroding surface at a time. Whole watershed approaches connect elements in a more inclusive or complete model. Whole approaches are best for problem and sensitivity analysis and for actual quantification of pollution.

The Revised Universal Soil Loss Equation (RUSLE), now replacing the USLE, is a process-based model (Renard et al., 1991). RUSLE has a new R factor that is more accurate for the rainfall/erosion conditions of the western U.S., a seasonally-variable K factor to account for changes in stability of soil structure, new L and S algorithms reflecting rill and interrill erosion, and new P values for rangelands and for effects of subsurface drainage.

A more completely process-based model, from the Water Erosion Prediction Project (WEPP), is now being tested for implementation (Laflen et al., 1991). This is a procedure to quantify detachment, transport and deposition of sediment. A "watershed version" that computes sediment transport, deposition and detachment is designed to be applied to field-size watersheds.

Another regression model with watershed applicability is the Agricultural Non-Point Source Pollution Model (AGNPS) (Young et al., 1989) which estimates soil loss and nutrient production as NPS runoff for a set of connected landscape units. The AGNPS model was originally developed by the Minnesota Pollution Control Agency and the USDA to simulate sediment and nutrient transport from agricultural watersheds in Minnesota. It is now used primarily by the Soil Conservation Service of the USDA. AGNPS predicts water quality in watersheds using a computer simulation of sediment and nutrient transport.

AGNPS divides an agricultural watershed into geographic cells. Each cell is assigned a value representing the sediment and nutrient production that can be transported via overland flow to the stream. The model simulates the transport of sediment, nutrients, and flow from the headwaters of a watershed to the outlet for a single storm event. Information from the watershed outlet can be used to assess the potential pollution hazard from the entire watershed, while the output information for each cell can be examined to locate those local areas within a watershed that contribute the greatest amount of pollutants to a waterway.

Conceptually, the model would be useful anywhere. Considerable data are required to calibrate the model parameters and re-shape algorithms to represent realistic responses for a given watershed. The method begins to address the spatial complexity of source areas, sensitivity, and potential routing of impacts from the location of activities. The model does not address in-stream routing, fate, or effects of pollutants. These uncertainties increase with size and complexity of watersheds.

While AGNPS was developed specifically for agriculture, other systems have been developed for silviculture, with the goal of quantifying cumulative effects and fisheries impacts. The Klock model (Klock, 1985) is a cumulative effects predictor, based on land use, climate, erosion, and watershed sensitivity. It was developed to respond to concerns about potential cumulative watershed effects on downstream aquatic ecosystems from multiple management activities over time and space. The model provides an index of the condition within a watershed in relation to the implied risk of further degradation from additional forestry activities.

An index of watershed condition is calculated using an equation that incorporates ecosystem parameters using several coefficients, which together calculate the cumulative effects risk of past, current, or future forest practices. The coefficients include:

1) site erosivity energy potential (based on precipitation),
2) surface erosion,
3) slope stability,
4) hydrologic sensitivity,
5) topographic factor,
6) area of activity, and
7) total area of watershed.

Coefficients were developed to represent conditions in forested central Washington watersheds. This method is useful as a relative rating of sediment yield among small basins. It assumes that large basins will not respond if the small basins do not. The method does not address sediment routing or the sensitivity of different stream segments to changes in the basin nor does it include large woody debris or human impact.

While the Klock model may be faulted for being too general, a model can also be extremely specific, and hence less useful for overall watershed assessment. The USFS Sediment/Fish Model, also called the R-1/R-4 method, focuses entirely on fishery impacts to trout and salmon from land use practices (Cline et al., 1981; Stowell et al., 1983). The Reeves" Limiting Factor Analysis is designed specifically for coho salmon (Reeves et al., 1989). These models get strength from their specificity, and serve as examples for connecting impacts to beneficial uses. Reid (1991) notes:

> When [cumulative impact assessment] methods originate from management agencies, they tend to be simple, incomplete, theoretically unsound, unvalidated, implementable by field personnel and heavily used. When they are developed by researchers, they are more likely to be complex, incomplete, theoretically sound, validated, require expert operators, and unused. Only in the cases of the R-1/R-4 method and the Limiting Factor Analysis have management and research backgrounds been combined to produce methods...(that) rank among the highest in defensibility, scientific basis, and utility.

The Sediment/Fish model was developed by the USFS and university researchers for application in the Idaho Batholith. The method predicts the impacts on fish survival as a result of forest practices that affect sedimentation rates in streams. Sediment yield in the Sediment/Fish model is extrapolated from results of local research that relates erosion rates to land use. Coefficients are developed to represent the change in sediment yield that would result from proposed harvest practices. The impact on fish survivability is estimated relative to current conditions using relationships between sediment yield and substrate embeddedness, between substrate embeddedness and fish habitat, and between habitat quality and fish response. If natural siltation levels are known, and conditions prior to the project are measured, then the incremental effect of a planned project can be predicted. This method relates land use activities directly to resource response. The approach is appropriate in areas where deposition of fine sediment is the major impact on fish and where sediment is eroded primarily by surface erosion on logged sites and roads.

Reid (1991) notes that the Sediment/Fish model is not complete in evaluating cumulative impacts because it addresses only one type of impact resulting from one type of source. Insufficient attention is given to error and other sources of variation and to the differing sensitivity of species to changes in sediment. Results from the model give a broad estimate of trends and impacts rather than precise predictions of change.

The limitations in the Sediment/Fish model are those of regression models in general. They are good for relatively homogeneous areas and for predictions based on coefficients of impact. When critical sites are important, or when many of the watershed's processes do not follow the model's assumptions, they are poor predictors. As with most systems, if researchers go into the field, model in hand, and test its assumptions in small areas, they can best judge its applicability.

### *6.2.3. Deterministic and Physical Models*

Deterministic models of watersheds simulate hydrologic processes with a series of submodels representing such watershed parameters as precipitation, water storage, water loss, and water flow (Larson et al., 1982). These models have generally been used for predicting large watershed river response, as in the Stanford watershed model, the USDA HL-74 model, the SCS TR-20 model, the SSARR model, HEC-1 and ANSWERS. Newer versions of these models often include sediment transport. Deterministic models are appropriate for flood modeling, for reservoir sediment prediction, and for water yield studies. They have not, at this time, been used for the prediction of watershed impacts on beneficial uses, but they have that potential.

The In-stream Flow Incremental Methodology (IFIM), a deterministic model for stream processes coupled with a habitat module, has been used extensively on federal projects (Bartholow and Waddle, 1986). This approach connects the rising water in a stream to the habitat elements it creates or reveals. The IFIM relies on separate modules for habitat response. While this may not be the ideal methodology for stream habitat or watershed assessment, it is in wide use. Researchers and managers need to evaluate it as an alternative approach.

Physical models of watershed processes can be useful for prediction of phenomena where adequate data exist and over which researchers have tight controls. These models start from first principles: gravity, soil permeability, soil hydraulic conductivity, and the surface tension of water. At this time, their applicability is still being tested on small watersheds but the complexity of processes and the variability of the landscape present real limitations to model practicality. Moore et al. (1988), for instance, suggest developing predictive models of surface and subsurface flow for modeling solute and sediment transport, based on digital elevation models. While some landscape components such as solar radiation may be effectively predicted with this form of input data, other components, such as the transmissivity of soil, rely heavily on assumptions of uniformity. At some time, it may be possible to account for variations in soil depth, rock fractures, and small topographic features. Real world experience shows that accelerated erosion is a site specific phenomenon, often determined by the location of roads and stream channels within the unique mélange of the landscape. Biodiversity components and processes are equally complicated, site specific, and difficult to model. Goodrich and Woolhiser (1991) state:

> Modeling efforts or evaluations based on simulated input-output data may be used to gain model insight but are of little real world value....Those model evaluations which utilized observed data, do not paint an encouraging picture of our ability to model catchment response.

The best application for physically-based models will be where data is strong and the surface has little variability, including rainfall variability. Coupling these specific models with specific data on road drainage, field runoff, or other measurable parameters will yield useful answers to questions about watershed beneficial uses.

### *6.2.4. Probability Approaches*

Planning the size of a drainage culvert for a road is a probability analysis. The input information is the size of the watershed, the estimated concentration time for the watershed, and the maximum expected storm size for a given period of years. This is a prediction of watershed response, from the perspective of the road. More sophisticated methods may be called risk analysis, particularly when applied to beneficial uses. Lewis and Rice (1990) give a method for prediction of landslides occurring from forestry or road construction activities based on degrees of certainty.

Other problem assessments determine the likelihood of a "worst-case" scenario. Such assessments are important in pollution control. What is the probability of a carload of pesticides falling into the river? What will be its effect on beneficial uses? Worst-case analysis is important because the unlikely event may have profound and lasting effects on watersheds compared with small scale, more frequent impacts. Cumulative impact predictions should incorporate these scenarios so that managers consider catastrophic events.

At this time, there are watershed assessment systems that statistically rank the probability of landslides or flooding events. The TFW Assessment addresses probability in an expert system and develops matrices of "likelihood of delivered impacts" versus "resource vulnerability," using this to develop recommendations for management (WFPB 1994). The EPA has developed a risk-based framework to minimize the loss of wetland functions. It includes risk assessment, risk management and follow-up monitoring to evaluate effectiveness (Leibowitz et al., 1992). Risk assessment includes stressor/response relationships and exposure assessment. The framework responds to the need to focus environmental protection efforts on those problems that pose the greatest risk and in those areas where greatest risk reduction can be achieved.

From the beneficial use perspective, actual and relative probability analysis is a useful route for research and a challenge for managers. GIS-based watershed analyses may be the most effective approach in the arena of risk assessment because they allow overlays of beneficial uses, likely impacts, and potential effects. Nonetheless, it will always be up to people, including the land managers, the public, and the political process, to determine the amount of risk society wishes to take.

### 6.3. Comparison of Methods

Table 3 listed some questions that could guide selection of a method for watershed assessment. A sample of these questions has been used in Table 4 to show how the different methods could be evaluated as a first step to choosing the appropriate method for a particular situation.

### 6.4. Adaptive Management

It must be acknowledged that predictions are imperfect and that outcomes may not match predictions under any assessment system. This important fact must be recognized in those cases where beneficial uses suffer unrecoverable losses due to poor predictions. In order to maintain a sustainable environment, we need to inventory resources, predict impacts, implement management, monitor outcomes, and change our strategies when necessary. This complete loop is the essence of adaptive management.

> Adaptive management treats management programs as experiments. Rather than assuming that we understand the system that we are attempting to manage, adaptive management allows management to proceed in the face of uncertainty. Adaptive management uses each step of a management program as an information-gathering exercise whose results then are used to modify or design the next stage in the management program. In adaptive management, there is direct feedback between science and management such that policy decisions can make use of the best available scientific information at all stages in its development (Halbert, 1991).

Adaptive management is described in the TFW and NCASI approaches, which aim to improve models with future data. It is addressed in the FEMAT report, and may be found in some CRMPs. In some ways, adaptive management may be seen as injudicious, because it allows present management to continue, within constraints, until a red flag is raised on mistakes. The adaptive management concept presumes that the high impact activities which are measured will not lead to unrecoverable changes.

Managers taking these approaches must recognize that some mistakes in prediction are inevitable, and the ensuing loss may be essentially permanent. To limit the severity of losses, it may be prudent to apply other strategies in selecting "experimental" zones, using, for instance, the AFS or Gap approaches. Identification of critical habitats, and the processes which maintain them, at the beginning of watershed assessment can offer those habitats protection from activities which have the potential to cause significant, long-term damage.

## Table 4. Some Comparisons of Watershed Assessment Methods

| Method/ Assessment | Inventory or Model | Frequency of Assessment | Area of Assessment | Information Needed | $ Cost | People Cost | Assessment Results |
|---|---|---|---|---|---|---|---|
| **Stream Classification** | inventory | five to ten years | second to fifth order watersheds | application of survey | medium to low | several people, specialist to train, coordinate and analyze | current conditions, relative changes |
| **Physical Stream Characteristics** | inventory | initial assessment and as resources change | first to fourth order watersheds | cross-sections, plan maps or other measures | medium startup, low to medium continuing | several people for each survey, specialist to train | changes in channel, bed, banks and cover |
| **Watershed Characteristics** | inventory | initial assessment and as resources change | third to fifth order watersheds | geology, soils, vegetation, roads, land use, topography, and stream system | increasingly high with resolution; GIS helpful | specialist for setup, technician to maintain | geology, soils, stream channels, and ecologic information |
| **Gap Analysis** | inventory | initial assessment, as resources change, or with new information | large; limits defined by ecosystem | ecological components | increasingly high with resolution; GIS helpful | specialist for setup and analysis, technician to maintain | ecological cores, buffers, corridors and hot spots |
| **Water Column** | inventory | depends on parameters | second order and larger | in-stream samples taken within a sampling system | moderate to high for frequent data collection; analysis varies in cost | high, requires people on site at critical times | chemical and physical parameters of water quality at points in time |
| **Runoff and Precipitation** | inventory | 15 minute to daily | third order and larger watersheds | gage data | medium startup, low continuing | low but often, high for large area or large floods | runoff timing, flood frequency |
| **Sediment Budget** | inventory | once in detail, yearly update | small area details, up to large watersheds | field data, airphotos, stream data possible | high startup, low continuing | several personnel startup, annual updates | source specific erosion rates |
| **Integrated Systems** | both | as necessary, depending on critical resource | third order to fifth order | same as watershed characteristics | moderate for survey, high for analysis | high, requires both field data and specialists for analysis | probable responses of resources relative to proposed impact |
| **Expert Systems** | model | once, with updates | varies | varies | low to moderate | moderate: specialists for analysis of previously gathered information | likely impacts based on experts" opinions and existing data |
| **Regression Methods** | model | once | varies | varies; some methods require great detail | low | low: methods are designed to be applied by nonspecialists | likely impact with respect to the model's design |
| **Physical Models** | model | once | varies | detail on physical elements | high: field data needed to fill in detail | high: requires specialists through the process | detailed information limited to model's specific inputs |
| **Probability Models** | model | once | varies | historical records as available or created by interpolation | moderate: limited data sets restrict analysis | moderate: specialists needed for setup | likely variation of measured resources into the future |

# 7. IMPLEMENTATION OF WATERSHED MANAGEMENT

> Ideas can have strong intuitive appeal, yet not affect decisionmaking because they lack any explicit operation formulation. Cumulative impact is such an idea...The notion that individually insignificant actions can produce major change through the accumulation of effects is compelling enough to have influenced federal legislation ...initiated court action, and produced international meetings. Yet constraints remain more obvious than any specific approach or method for implementing this idea in natural resource regulation and management (Preston and Bedford, 1988).

Methods of watershed assessment identify and rate the magnitude of potential or actual impacts. Implementation of watershed management practices requires an assessment of the significance of these impacts, and the risk or probability of occurrence. A major concern is how, and how well, impact magnitude can be interpreted as impact significance. Magnitudes are based on measurements, but significance is based on an aggregation of the effects of different impacts and includes other factors such as costs. Determining significance requires public participation to incorporate values.

The following sections provide some examples of how land managers and public and private groups use watershed analysis to make watershed management decisions for different land uses. Programs of land management agencies and some state non-point source programs are reviewed.

## 7.1. FORESTED LANDS

Megahan (1992) summarized the watershed condition assessment methods used on forested lands into six categories. The methods are used singly or in combination.

1) Monitoring for effectiveness of best management practices with an evaluation based on a threshold established for each monitoring element. These evaluations are often water column measurements, but may include physical and/or biological measurements, and habitat surveys.
2) Screening based on questions in a checklist to evaluate hazards and risks.
3) Indices based on factors influencing the geomorphic performance of a watershed.
4) Use of an interdisciplinary team of technical specialists to evaluate watershed conditions, processes, and status of the watershed. This procedure identifies anticipated effects, with the results then used to modify management.
5) A combination of 2, 3 and 4 into an Equivalent Roaded Area procedure. This method may include an assessment of watershed sensitivity based on potential changes, a field investigation of the physical characteristics, and the establishment of a threshold to guide changes in management.
6) Approaches based on an assumption that forest management activities affect one or more basic geomorphic processes such as streamflow or sediment production. These processes are monitored.

The Equivalent Clearcut Acres procedure, based on peak flows that could cause channel disturbance, is a hydrologic recovery procedure. The runoff curve number used by USDA–SCS to estimate storm runoff hydrography is used for watershed management planning. The Universal Soil Loss Equation has been adapted for use on forest lands. The recent Revised Universal Soil Loss Equation and the Watershed Erosion Prediction method now being tested by USDA are also being adapted to forested lands. A stability analysis to evaluate probability of occurrence of shallow landslides is used in some cumulative effects assessment procedures. A procedure to estimate annual sediment yields from watersheds, both under natural conditions and with various types of disturbance, is used in a number of forests. The procedure also includes modules on erosion from roads and sediment delivery to streams.

### *7.1.1. U.S. Forest Service*

The Forest Service carries out watershed condition assessments under the overall guidelines of cumulative effects assessment requirements. Different Regions and different Forests use somewhat different methods and calculate different indices, using Equivalent Roaded Area or Equivalent Clearcut Acres. They all identify values at risk and predict the results of a proposed action. The watershed condition assessment (inventory and assessment) determines the level set for the threshold of concern, which then guides management practices.

### *7.1.2. Private Forested Lands*

The control of non–point sources of pollution on private forested lands is based on regulations at the state level. The Oregon Forest Practices Act, for example, specifies management procedures (BMPs) for protection of streams against sediment loads. The required BMPs are updated periodically. Cumulative effects are considered only indirectly. Other states in the Northwest have similar regulations.

The Washington Timber, Fish and Wildlife (TFW) procedure (Washington Forest Practices Board, 1994) is a watershed condition assessment method that allows local input into setting objectives. The method identifies sensitive areas and the hazards to these areas, and provides scientifically valid information for management decisions to address these hazards. An assessment of watershed processes leads to area–specific prescriptions, either regulatory or voluntary, depending upon landownership. This procedure would then lead to appropriate management actions.

There is concern that the TFW process is too complex to be widely adopted. The time required for training and certification to obtain consistent results and the time required for on–site evaluation are large, and the components complex. Landowners may be reluctant to use such a method. Experience gained in this process will streamline the procedures. Sensitivity analysis would indicate which factors require more time and which factors could be measured or estimated more quickly.

The other difficulty, shared by most methods, is how the information will be used to effect change. How will the tradeoffs that are identified be evaluated in the implementation on public and on private lands? How will effectiveness be monitored and evaluated?

## 7.2. BUREAU OF LAND MANAGEMENT

BLM's priorities in addressing cumulative effects are to develop quantification of hillslope processes to predict soil erosion and downstream transport of sediment. This technique will be used to assess impacts of management practices on soil, water, and fisheries, and to make decisions on mitigation and management plans to be implemented on BLM land. There is an emphasis on quantitative numbers for soil erosion.

The BLM in Oregon uses a watershed condition index based on physical measurements and estimates of erosion potential. The process defines beneficial uses, determines the risks involved, and then determines how sensitive the particular landscape is to impacts. In general, the BLM plans to do cumulative effects analysis based on the NCASI procedure (Megahan, 1992), that is, a screening followed by a second level of more intensive analysis. If impacts are not found, or if they are acceptable, the analysis is complete. If impacts are significant, another tier involving more specific measurements is used, along with models for precipitation, runoff, and erosion.

## 7.3. CROPPED LAND IN AGRICULTURE

Most cropped land is under private management, where watershed protection measures are on a voluntary basis. The landowners have the resources of research, education, technical information and cost–sharing for watershed management provided by various USDA agencies, such as the Agricultural Research Service, Cooperative States Research Service, Cooperative Extension Service, Soil Conservation Service (SCS), and Agricultural Stabilization and Conservation Service (ASCS). In addition, state and federal water quality agencies are now important sources of information, guidance, and funding.

Models are used to predict water chemistry on a field scale and on a watershed basis. AGNPS and SWRRBWQ methods predict erosion and sediment detachment and transport across the landscape through chemical transport and erosion model components. The SCS soil surveys provide information for watershed assessment and water quality predictions. Most of the concern is directed to individual farmer's fields, but some cumulative watershed effects analysis is being undertaken on several watershed projects.

Watershed protection is implemented in some model watershed areas under the USDA Hydrologic Unit Area and Demonstration Project programs. There are several such watersheds in the Pacific Northwest. Benchmarks are established and monitored for water quality goals. Watershed management is also a focus of the Highly Erodible Lands program, again with education, technical assistance, and cost sharing, for voluntary adoption of practices to protect the soil surface. Enforcement is limited, and comes through cross–compliance, that is, denying participation in commodity support programs if conservation measures are not adopted. Some financial incentives to fill wetlands or to put highly erodible lands into cultivation have also been removed.

Other categories of non–point source pollution are addressed through best management practices (BMPs) adapted to specific agricultural production systems. The ASCS has lists of approved BMPs. Figure 5 illustrates how BMPs can be used and evaluated. Establishing a clear causal relationship between BMPs and improved watershed conditions or improved water quality is often difficult. Some long–term experiments and evaluation of this relationship are underway through monitoring (Dressing et al., 1993).

### 7.4. Indian Tribal Lands

The Indian Tribes make management decisions on tribal lands and also influence management decisions on the ceded lands. Watershed management is an increasing concern for these managers. Much of the concern has focused on management for fish habitat, but forestry and agriculture are important components on some tribal lands. Physical habitat methods are frequently used for watershed condition assessment.

Management decisions for lands on the Warm Springs Reservation in Oregon, for example, are based on a watershed model used on National Forest lands. Coefficients for processes such as sediment production are evaluated on the basis of Equivalent Roaded Area, and thresholds are set which become the basis for management decisions. If an activity will result in a threshold being exceeded, that activity is not carried out or mitigation is recommended. Areas where the effects already exceed thresholds are managed in a way to gradually decrease effects to below the thresholds.

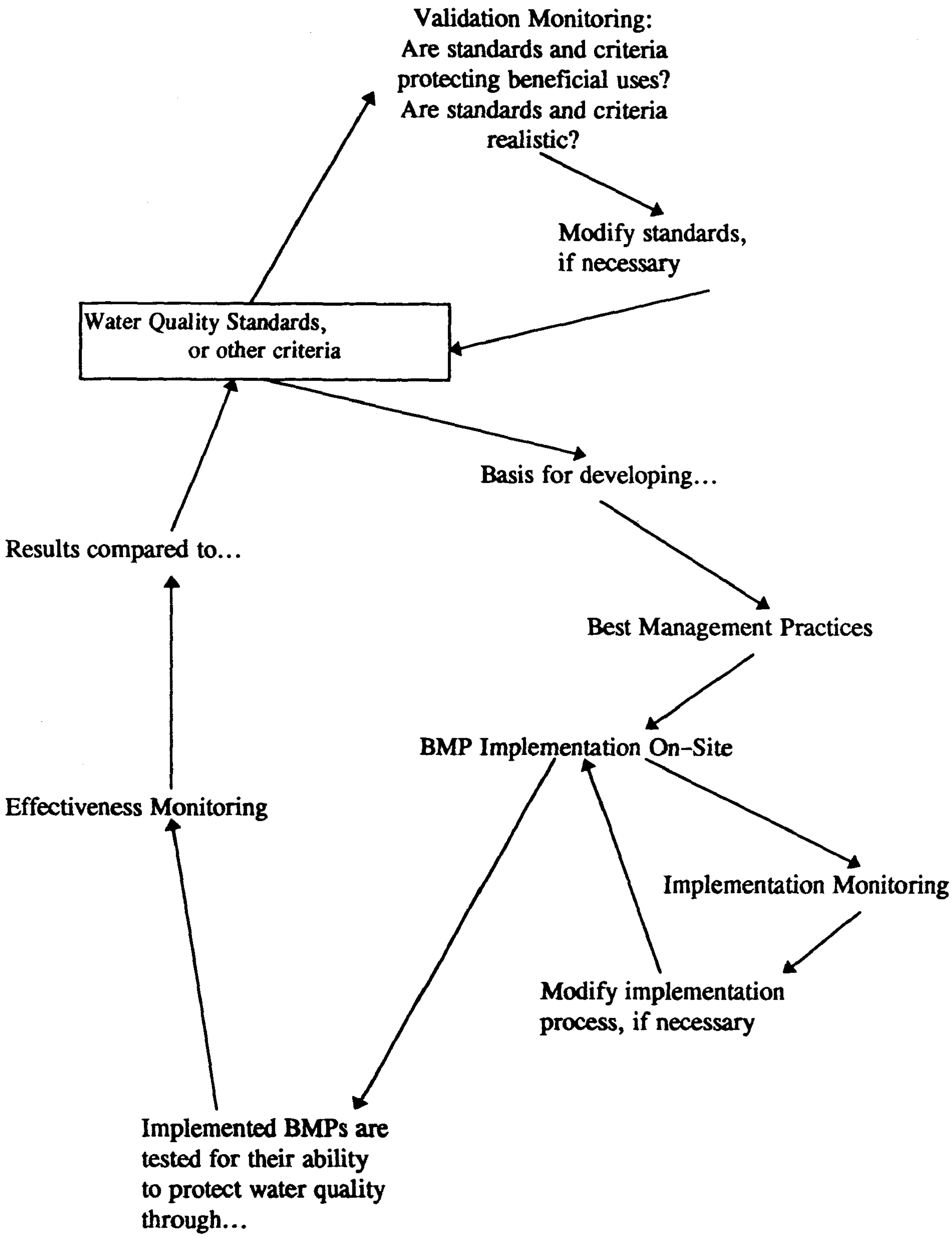
### 7.5. Parks

The lands managed under federal, state, and local parks are areas chosen because they contain specific ecological features. Areas within the parks represent unique opportunities to maintain biodiversity and ecological integrity for a range of plant and animal communities. Parks are ideal places to conduct research on how to sustain this biodiversity. Parks may not be representative of other lands, but they are often closer to a pristine condition. As such, they become important in watershed assessment because they represent relatively undisturbed ecosystems. Comparison of these systems with disturbed systems can then provide information on what functions have been changed, and how management can restore these functions. Watershed assessment studies are being carried out in a limited way in some parks. A plan for a National Park Service ecological research program is described by Risser and Lubchenco (1992).

### 7.6. State Regulatory Agencies

State agencies regulating use of different natural resources employ watershed assessment methods to reach decisions on how resources can be used. The watershed assessment method used by the Oregon Department of Fish and Wildlife has five components: 1) Physical and biological attributes, as well as land and water uses in a watershed, are compiled from maps and aerial photographs, 2) Fish reconnaissance inventories are used to determine species composition, distribution and relative abundance, 3) Quantitative stream

**Figure 5. Best Management Practices Feedback Loop**

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inventories are used to describe type and amount of habitat using a Hankin and Reeves method to estimate extent of each habitat unit based on stream reaches. Attributes include gradient, substrate, woody debris, shade, in–stream cover and bank stability, 4) Other appropriate attributes are measured, and 5) Population inventories are taken to provide information on fish populations.

This method is part of an aquatic inventory project begun in 1990. The goal is to develop and implement fish management plans and policies. The technical information is used to protect critical freshwater habitat and to restore degraded habitat. A classification system will be used to allow extrapolation to streams that were not surveyed (Jones, 1993). This method is compatible with surveys used by other agencies. Quality control is achieved through duplicate surveys to assess replicability of habitat surveys and measured differences within a crew and between crews.

## 7.7. The Puget Sound Plan

The Puget Sound Water Quality Authority, as restructured in 1985 by the Washington State Legislature, was charged with developing and overseeing the implementation of a comprehensive management plan for waters in the Puget Sound (Puget Sound Water Quality Management Plan, 1991). The plan called for initial updates on a two year cycle, and after 1999 on a four year cycle. The enabling legislation required state agencies and local governments to evaluate and incorporate applicable provisions of the plan into their policies and activities. The first plan, in 1986, involved an advisory committee, a scientific review panel, and public input from citizens in all the affected counties. The 1987 amendments to the Federal Clean Water Act added new responsibilities under the National Estuary Program.

The goal was to restore and protect the biological health and diversity of the Puget Sound. The Sound shares many characteristics with other ecosystems that need protection. It is a unique resource under divided jurisdiction, with no one entity able to adequately address the problem. Under the overall legislated mandate of the Puget Sound Water Quality Authority, local leadership is involved on a watershed–by–watershed basis. The program shows how the components can be put together into an action plan for non–point source pollution control. Local committees in each county identified and ranked the watersheds. A watershed management committee was set up to develop action plans to prevent and reduce non–point source pollution in watersheds on a priority basis.

Watershed action plans are developed in four phases. The counties are generally the lead agencies for each watershed management committee. The first phase consists of watershed characterization and setting specific objectives. Current conditions are assessed, risks and threats to beneficial uses are identified, priority problems are defined, and goals and objectives are developed. The characterization is prepared under the direction of the lead agency with input from a watershed management committee. An interagency river basin team is available for technical assistance. The second phase of the action plan is the non–point pollution control strategy that addresses priority sources and pollutants identified by the committees. The non–point pollution control strategy is prepared, consisting of voluntary educational and regulatory approaches for controlling the identified sources of the problem pollutants and based on feasibility, likelihood of success, and cost. Phase three is the implementation strategy, including coordination with all the other agencies and programs affecting the watershed. The implementation strategy is developed, including milestones, financing, and long–term monitoring. The fourth phase is the review and approval of the action plan. Public hearings are held and the action plans are reviewed and submitted for approval.

As of this writing, 16 watershed action plans have been completed and are now in the implementation stage. In addition, 20 more watershed action plans are being developed.

### 7.8. A Watershed Approach in the Coeur d' Alene River Basin

Although mining is regulated by a variety of laws, no program provides a comprehensive approach to watershed restoration in mined landscapes. Consequently, a number of watersheds throughout the West suffer from cumulative impacts from mining and other pollution sources which preclude attaining water quality goals.

Massive ore deposits were discovered in North Idaho's Silver Valley in the 1860s. The Coeur d'Alene mining district was a leading producer of lead, silver and zinc for over a century. During much of this history, mine wastes and tailings were discharged into the river and now form unstabilized deposits in the valley floor and in stream, river, and lake sediments. Lead, zinc, and cadmium are the primary toxic metals of concern.

The Coeur d'Alene Basin Restoration Project (Id. Dept. Health and Welfare, 1993), begun in 1991, provides an example of a multi–agency cooperative approach to watershed assessment and restoration. It addresses the CWA requirements for Total Maximum Daily Loads (TMDL) through an iterative procedure. It is recognized that an accurate load allocation is not possible given the mix of point and non–point sources in the watershed. Therefore, the conceptual approach is to utilize existing information to get a first approximation to a TMDL; to address the obvious problems on a short–term basis; and then to continue to analyze and to evaluate pollution sources as additional information becomes available over time.

The Coeur d'Alene Basin Project is based on a Memorandum of Agreement between EPA, Idaho Dept. Health and Welfare, and the Coeur d'Alene Tribe. The Agreement coordinates the authorities of the Clean Water Act (EPA and Idaho) and Natural Resources Damage Assessment provisions (Tribe) of CERCLA. The Project is coordinated by the Steering Committee and three additional groups — the Coeur d'Alene Basin Interagency Group, the Citizen's Advisory Committee, and the Management Advisory Committee — which encompass local, state, and federal agencies, and private interests.

The project framework is divided into water quality, hazardous waste (CERCLA/RCRA), human health, and wildlife habitat protection objectives. The framework includes the following activities:

- Gather natural resource information from existing data bases and identify additional information needs,
- Identify and verify environmental problems using this information,

- Identify problems that can be addressed quickly, within the next 2–3 years, under existing federal, state, tribal and local authorities using currently available resources,
- Take necessary short and long term actions to restore and enhance fishing, swimming, and recreation,
- Avoid duplication of effort by coordinating state, federal, and local laws, and
- Develop funding mechanisms to provide the Coeur d'Alene Basin project with the ability to set priorities and implement specific projects.

A critical assumption of the Couer d'Alene program is the reliance on a multifaceted and multidisciplinary approach to watershed assessment and restoration. The watershed approach requires expertise in the fields of environmental quality, human health, fish, and wildlife resources. This array of expertise is not housed in any single agency but rather is spread across a number of local, tribal, state and federal agencies, and private parties operating in the basin.

## 7.9. The Wisconsin Watershed Program

The Wisconsin Department of Natural Resources has a program for integrated watershed management, focusing largely on non–point sources of pollution(Wisconsin Watershed Program, 1993). Point sources are not yet satisfactorily integrated into the program. Watersheds are identified on a priority basis, and plans are written based on integrated resource management principles. The specific nature of these management plans depends upon the needs of specific watersheds and also, importantly, on the interests of the personnel and agencies working in that area. Issues could include wetlands restoration, fish habitat, wildlife habitat, endangered species, or water quality. A master monitoring program is included, with water chemistry data at fixed sampling points and biological data at the same sites. This monitoring is carried out only in certain priority areas because of the large resource requirements of such a program.

The different agencies with responsibility for aspects of these programs work together in writing and in implementing the plan. The program presents opportunities for integrated watershed management. Successful implementation depends upon the interests of the participants and cooperation among agencies.

An important aspect of the success of this watershed management program is an easement component, funded from special Stewardship Funds and non–point funds to purchase non–point easements to remove sources of pollutants. For example, an easement could be purchased to remove certain livestock activities from areas adjacent to a stream. These activities would be relocated elsewhere. The funds are useful for farmers who plan retirement and also for younger farmers who can then fund major improvements. BMPs are also funded through the Department of Natural Resources.

The important components of the program are a commitment to identify priority watersheds and to draw up management plans on a watershed basis, funding to encourage private landowners to participate in the non–point source pollution prevention program, and the opportunity for agencies to work together in planning and implementing the program. A large amount of time and energy is required to assure that all the different components of the program are working and to assure participation from all the different people who should be involved.

## 8. CONCLUSION

There is no single correct way to analyze a watershed. The "best" way depends on the beneficial uses of the watershed, and the goals of the researchers, the landowners, the community, and the downstream users. Significant constraints of time, money, and expertise restrict the data collection and analysis process. Methods for watershed assessment are experimental at present; they take different approaches, and yield different results.

It is important for watershed assessors to recognize the varying approaches to assessment because their recommendations will result from the questions they ask. As federal, state, and local authorities become progressively more interested in watershed management and water quality assessment, researchers will find themselves wedged between different scientific approaches, goal–oriented strategies, and landowners and agencies with very different agendas. Watershed assessment begins as science but may become a political tool.

The necessary attributes of a watershed assessment strategy are:

- flexible, to focus on particular issues,
- diverse, to assess the spectrum of resources and uses,
- scientifically based, to find the causal links with degradation and thus allow meaningful recommendations,
- robust, so they may be applied by people with limited training,
- strict, so protocols are kept and separate studies may later be compared,
- time insensitive, so they may be applied throughout the year,
- statistically strong, so they are not thrown off by variation in environmental parameters,
- cautious, so important or sensitive elements are not overlooked,
- mutually agreed upon, so that their recommendations may be implemented, and
- part of a long–term management strategy.

In addition, the systems must incorporate some form of prediction and adaptive management. This approach allows for correction of errors in either implementation or monitoring techniques.

At present the best systems appear to be those that incorporate both inventories and expert opinion. These systems will improve with increased resolution of the inventories.

Feedback from adaptive management will also serve to educate the assessors. As we increase our knowledge of watersheds, we will rely less on expert opinion, and the assessments will be less subject to differences among experts who assess risk differently.

The critical moment in selecting assessment strategies is at the stage when the goals of the assessment must be made explicit. At this time, when consensus from watershed owners, agencies, and users is required, the process can easily become derailed. The consequences of a multi–year data collection project collecting the wrong data will be severe; the loss of trust, time, and money generated by the misguided effort will hamper future assessments.

Currently, federal and state laws have joined at the watershed level, mandating assessments of cumulative effects for the benefit of fish, wildlife, vegetation, and people. The next goal should be finding and applying watershed assessment methods that carry out the intent of our laws through effective assessments. With implementation and adaptive management, we can achieve improved water and habitat quality. Watershed assessment will document the improvement in our environment, as well as help design management and restoration activities.

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Appendix A

## METHODS FOR WATERSHED ASSESSMENT

Section 6 of this report discusses the generic characteristics of both inventory and predictive methods for watershed assessment. This appendix lists additional assessment methods, with brief summaries for some of them. This could serve as a guide to choosing appropriate methods. The methods are grouped according to the type of measurement.

## 1. Methods Based Largely On Water Column Measurements

**Water quality problem identification in urban watersheds.** Livingston, Eric H. Florida Department of Environmental Regulation, Tallahassee, FL.

Measures pollutant loading to aquatic systems, and compares with loading that would give desired water quality. Application of water column measurements to urban watersheds.

**Water Resources Evaluation of Non-Point Silvicultural Sources (WRENSS).** US Forest Service, 1980. An approach to water resources evaluation of non-point silvicultural sources. (A Procedural Handbook). US EPA, EPA-600/8-80-012. 864 pp.

**AGNPS: A non-point source pollution model for evaluating agricultural watersheds.** Young, R.A., C.A. Onstad, D.D. Bosch, and W.P. Anderson. 1989. J. Soil and Water Cons. 44:168-173.

AGNPS is a distributed-parameter, storm-event-based model that estimates runoff, sedimentation and nutrient losses in surface runoff from agricultural watersheds. Developed by USDA (ARS and SCS) in cooperation with the Minnesota Pollution Control Agency.

**Assessment of cumulative impacts to water quality in a forested wetland landscape.** Childers, Daniel L. and James G. Gosselink. 1990. Journal of Environmental Quality 19:455-464.

Assessing changes in landscape integrity over time using structural and functional ecosystem indices. Used historical and continuing measurements of sediment and nutrients to document changes. Devised a management plan for improved water quality based on the cumulative impact assessment. The plan included changing river flow patterns, best management land practices, and vegetated buffer zones next to streams. The method is based largely on chemistry of the water column, so is specific to part of the watershed analysis problem.

**Simulator for Water Resources in Rural Basins - Water Quality.** USDA, SCS, 1991. (SWRRBWQ).

Continuous simulations of hydrologic and related processes, to predict effect of management practices on water, sediment, nutrient and pesticide yields at the basin or subbasin outlet.

**Hydrology Simulation Procedure–Fortran (HSPF).**

This is a very detailed simulation model for hydrology and loading of water bodies from non-point sources on land. It is based on the Stanford watershed model, as used by EPA.

## 2. Methods Based Largely on Physical Characteristics of the Watershed or its Components.

**Methods for evaluating stream, riparian, and biotic conditions.** Platts, W.S., et al., 1983. USDA For. Serv., Gen. Tech. Rep. INT–183, 71 pp.

**Cumulative impact assessment in environmental planning: a coastal wetland watershed example.** Dickert, Thomas G., and Andrea E. Tuttle. 1985. Environmental Impact Assessment Review 5:37–64.

Based on managing landscape changes so the impacts remain below a critical threshold value. The method uses susceptibility to erosion and measurement of land disturbance. This is similar to the methods based on landscape measurements and is applied to the planning process.

**Quantifying stream substrate for habitat analysis studies.** Bain, M.B., et. al., 1985. Nor. Amer. Jour. of Fish. Man. 5:499–500.

**A management model for evaluating cumulative watershed effects.** Haskins, Donald M. 1986. Presented at the California Watershed Management Conference, November 18–20, 1986. West Sacramento, CA.

The model is based on identifying sensitive landscape areas based on physical characteristics, on identifying management activities through the Equivalent Roaded Area, and comparing the two with a threshold of concern. The ideas are used in the ERA method of the USFS.

**A hierarchical framework for stream habitat classification: viewing streams in a watershed context.** Frissell, C.A., et al., 1986. Environ. Mgmt. 10:199–214.

**Summary Report for the 1988 Cumulative Watershed Effects Analyses on the Eldorado National Forest.** Kuehn, Michael H. and John Coburn. 1989. Eldorado National Forest, CA.

Uses the US Forest Service cumulative watershed effect approach, adapted to a specific location.

**Cumulative off–site watershed effects analysis.** US Forest Service, Region 5. 1988. Chapter 20, FSH 2509.22.

Measurement of physical watershed parameters to determine effects on beneficial uses of water. These methods contain some components of a complete watershed assessment.

**An inventory of fish habitat conditions on seven southeast Alaska streams identified by the EPA Section 304(l) long list.** Martin, Douglas J., et al., 1990. Unpublished. Interpretive Report: Project No. 00044–001. Prepared for SEAlaska Corp., Juneau, AK. Prepared by: Pentec Environmental, In., Edmonds, WA.

A method to assess the quantity and quality of salmonid spawning and rearing habitat in streams. Uses measured cobble embeddedness and bank stability as indicators for sediment, large woody debris as index of habitat for rearing, and riparian trees as measures of shading and future large woody debris. Done with a one–time site visit. This is a good example of a rapid assessment technique.

**Geomorphological watershed analysis: a conceptual framework and review of techniques.** Benda, Lee and Lynne Rodgers Miller. 1991. Prepared for Timber, Fish and Wildlife. TFW-SH10-91-001. Seattle, WA.

A conceptual framework and technical guidelines for evaluating present watershed condition and for predicting responses of hillslope and channels to changes in land use. For forest management in mountain drainage basins. Concentrates on erosion and channel processes, and causes (natural or manmade) of changes. Much of the material has been incorporated into the TFW process resulting in the Washington Forest Practice Board "Methodology for Conducting Watershed Analysis."

**The use of the qualitative habitat evaluation index for use attainability studies in streams and rivers in Ohio.** Rankin, Edward T. 1991. In Biological Criteria: Research and Regulation. US EPA, Office of Water. EPA-440/5-91-005.

Based on measurement of physical habitat variables for streams. Similar to other methods of calculating indices from physical metrics.

**Watershed Condition Index, Appendix 3-E: Analytical Methods.** Schloss, Alan J. 1991. Bureau of Land Management, Eugene, OR.

An index based on physical measurements.

**A quantitative habitat assessment protocol for field evaluation of physical habitat in small wadable streams.** Kaufmann, P. and E.G. Robinson. 1993. Oregon State University and US EPA ERL, Corvallis, OR. 26 pp.

A detailed protocol for quick, quantitative assessment of habitat, based on systematic spatial sampling design and measurement of physical characteristics.

## 3. Methods Based On Measurements of Biotic Communities

**The fish populations of the middle 340 km of the Wabash River.** Gammon, J.R. 1976. Technical Report No. 86. Water Resources Research Center, Purdue University, West Lafayette, IN.

Measurements of species distribution and diversity connected to indices used in identifying problem areas in the river. Ideas are used in biodiversity methods.

**Regional applications of an index of biotic integrity for use in water resource management.** Miller, D.L., et al. 1988. Fisheries 13:12-20.

Some adaptation is required for regions of low species richness, such as parts of the Pacific northwest. See Hughes, R.M. and J.R. Gammon, 1987. "Longitudinal changes in fish assemblages and water quality in the Willamette River, Oregon." Trans. Amer. Fish. Soc. 116:196-209.

**Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish.** Plafkin, James L., et. al., 1989. EPA 440/4-89-001. Office of Water. Washington, D.C.

Protocols for rapid assessment of macroinvertebrates and fish, including screening procedures and more intensive evaluations, to identify severity of impairment of desired function in streams. These five methods include components of approaches used by several states. Different taxonomic groups could be substituted, for example, algal communities. Complete descriptions of protocols are given, which can be modified for local conditions.

**Use of avian and mammalian guilds as indicators of cumulative impacts in riparian-wetland areas.** Croonquist, Mary Jo, and Robert P. Brooks. 1991. Environmental Management 15:701-714.

Based on the concept of measuring guilds, for example, groups of species that exploit the same class of environmental resources in a similar way. This becomes part of a Gap analysis.

## 4. Mixed Measurements

**The cumulative impacts of human activities on the atmosphere.** Clark, W.C. 1985. In G.E. Beanlands, and W.J. Erkmann, et al. eds. Cumulative Environmental Effects: A Bi-National Perspective. Canadian Environmental Assessment Research Council, Ontario, and U.S. National Research Council, Washington, D.C.

This is an excellent discussion of the background for cumulative impact assessment, on distinguishing simple from cumulative impacts, and suggesting a synoptic approach using expert knowledge.

**General Aquatic Wildlife System (GAWS) — Implementing a fish-habitat relationship program through GAWS.** US Forest Service, Region 4. 1987. The Habitat Express, No. 87-2. Ogden, UT.

A tiered system of stream habitat assessment beginning with evaluation of available information (office level), then stream reach reconnaissance and finally site specific transect measurements for areas identified as requiring cause/effect studies. Combines physical characteristics and species diversity measurements. The concepts are used in recent tiered approach methods.

**An expert system approach to environmental impact assessment.** Lein, J.K. 1989. Int. J. Env. Studies 33:13-27.

A formalized procedure for incorporating human judgment and experience in watershed analysis, used at a screening level.

**Understanding the Minnesota river assessment project.** Minnesota Pollution Control Agency. 1990. St. Paul, MN.

Measurement of water column parameters of sediment, nutrients and bacteria, identification of sources. Measuring fish populations for biotic integrity and land use identification as a guide to stream restoration. Uses components of several methods that have been described.

**Oregon nonpoint source monitoring protocols stream bioassessment field manual for macroinvertebrates and habitat assessment.** Mulvey, M., L. Caton and R. Hafele. 1992. Oregon Department of Environmental Quality Laboratory Biomonitoring Section. 1712 SW 11th Ave., Portland, OR, 97201. 40 pp.

**Status of the NCASI cumulative watershed effects program and methodology.** 1992. NACASI Tech. Bull. 634, NCASI, 260 Madison Ave, NY, NY.

This is a guide for development of an assessment method that could be used by private and public land managers. It is a tiered approach with an initial screening "to assess watershed sensitivity, evaluate existing conditions, document the existence of important downstream watershed values, and define how changes in hydrologic processes caused by forest management activities link to downstream watershed values. A second level of analysis is needed when the screen predicts the existence or risk of unacceptable cumulative effects that cannot be controlled by management solutions. An example CWE module for dissolved oxygen is presented to illustrate the assessment process."

**Integrated Riparian Evaluation Guide.** 1992. US Forest Service, Intermountain Region, Ogden, Utah, prepared by a Technical Riparian Workshop.

An assessment of riparian areas based on stratifying and classifying areas according to their natural inherent characteristics and existing conditions. Uses a tiered approach with three levels of increasing detail, beginning with an office-based assessment, then a delineation of riparian areas based on field surveys, and finally quantitative data collection to answer specific questions identified at other levels. Considerable use of interdisciplinary teams at all three levels gives detailed protocols for measurement of aquatic community habitat, soils, hydrology and stream dynamics, vegetation and terrestical habitat. Defines resource ratings that can be used to effect management changes.

**Notes on cumulative environmental change II: A contribution to methodology.** Cocklin, C., et al., 1992. J. Env. Mngt. 35:51-67.

Combines a matrix structure showing the association between cause and effect with a GIS framework for analysis of cumulative effects on a regional scale. The GIS is a practical tool for cumulative impact assessment because it provides the ability to compile and evaluate data collected over a long time period and over a large geographic area

## 5. Planning Models

**Extending the capability of the component interaction matrix for addressing secondary environmental assessment.** Shopley, J., et. al., 1990. J. Env. Mngt. 31:197–218.

Identifies secondary environmental impacts that could result from proposed land uses, and the interdependence of environmental components, through a minimum link matrix.

**A framework for incorporating stream use in the determination of priority watersheds.** Wenger, Robert P., Yue Rong and H.J. Harris. 1990. Journal of Environmental Management 31:335–350.

Uses "fuzzy set" models to incorporate non-point source pollution measurements with stream habitat data to identify priority watersheds. This is useful background for thinking about watershed assessment.

**Modeling the cumulative watershed effects of forest management strategies.** Ziemer, R.R., et al., 1991. Journal of Environmental Quality 20:36–42.

**A standard format for use in the analysis of environmental policy.** Wescott, G. 1992. J. Env. Mngt. 35:69–79.

Places watershed assessment in the general context of environmental policy analysis.

**Appendix B**

## ADDITIONAL WATERSHED ANALYSIS LITERATURE

This appendix contains general references not cited in the report.

The letters in brackets after each citation indicate the type of literature, as follows:

B = Background and Overview

C = Components of Methods

M = Methods

P = Policies, Programs and Planning

R = Research

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**Appendix C**

# LEGAL AND POLICY ANALYSIS FOR INTEGRATED WATERSHED MANAGEMENT, CUMULATIVE IMPACTS, AND IMPLEMENTATION OF NON-POINT SOURCE CONTROLS

by

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December 31, 1993

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* The analyses and views presented in this report are the responsibility of the co-authors and should not be attributed to the Oregon Water Resources Research Institute, Oregon State University, University of Oregon, or State System of Higher Education.

## BACKGROUND

This stand-alone appendix, prepared by Professor Hildreth and law students Mara Brown and Robert Shavelson, reviews a number of legal and policy "handholds" for watershed management. It includes investigation of the legal and policy bases for watershed approaches to water quality management and the legal framework for cumulative impact analyses of activities in watersheds


## ACKNOWLEDGMENTS

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# 1. CUMULATIVE IMPACTS ANALYSIS: A BASIC FEDERAL LEGAL REQUIREMENT

## 1.1. THE NATION'S ENVIRONMENTAL MAGNA CARTA

Spurred by the public's growing distrust of government in the midst of the Vietnam War, and against a backdrop of oil-soaked birds and tainted shorelines caused by the infamous Santa Barbara oil spill, Congress enacted the National Environmental Policy Act (NEPA), 42 U.S.C. § 4321 et seq., in 1970 to "promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man." NEPA has been called the nation's "environmental Magna Carta," and for good reason: the act marked a radical shift in U.S. environmental policy by committing the entire federal bureaucracy to maintaining environmental quality and by opening federal agency decision-making processes to public and judicial scrutiny (Blumm in Symposium 1990).

A literal reading of the act, coupled with a review of the act's legislative history, suggests that NEPA holds promise as a vehicle for watershed protection. In declaring national environmental policy under section 101, Congress recognized "the profound impact of man's activities on the interrelations of all components of the natural environment," and declared "that it is the continuing obligation of the Federal Government...to use all practicable means...to create and maintain conditions under which man and nature can exist in productive harmony."

To achieve the directives set forth in section 101, Congress created various "action forcing" provisions in section 102 to ensure compliance with NEPA's broad environmental mandates. Significantly, Congress stated that "to the fullest extent possible...the policies, regulations and public laws of the United States shall be interpreted and administered in accordance" with NEPA's general intents and purposes. Among section 102's most important directives is the requirement that federal agencies:

> Include in every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment, a detailed statement ...on — (i) the environmental impact of the proposed action, (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented, (iii) alternatives to the proposed action, (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Agencies often prepare preliminary environmental assessments (EAs) to determine whether "a major federal action" will "significantly [affect]...the quality of the human environment." If so, then the agency must compile a more comprehensive environmental impact statement (EIS), complete with a review of cumulative impacts expected to flow from the proposed action, Oregon Natural Resources Council V. Marsh, 832 F.2d 1489 (9th Cir.

1987). If the EA determines that the proposed action will not significantly affect the quality of the human environment, then the agency can make a finding of no significant impact (FONSI), and proceed with the activity. Additionally, the regulations require agencies to prepare a Record of Decision (ROD) identifying all alternatives considered in reaching a decision and specifying the environmentally preferable alternative.

State legislatures in Washington, California, and several other states have enacted laws ("little NEPAs") patterned after the federal NEPA. These statutes require state and local agencies to assess the environmental impacts of their decisions affecting the environment including land use development approvals. To date those laws do not appear to have played a significant role in protecting watershed water quality. See, for example, J.C. Martinez v. City of San Diego, 4 Cal. Rptr. 2d 753 (Cal. App. 1992); Concerned Land Owners of Union Hill v. King County, 827 P.2d 1017 (1992).

Hundreds of law review articles and several books have been devoted to the theoretical and practical implications of NEPA implementation, and many battles have been fought in the courts over the various nuances of NEPA's purpose, scope and effect. However, this section will be limited to a discussion of judicial interpretation of NEPA's cumulative impacts directives as they relate to watershed protection. Yet before reviewing the cumulative impacts case law, it is important to understand how the courts generally perceive NEPA's mandates in a modern context.

### 1.2. NEPA AS A PROCEDURAL MANDATE

A plain reading of NEPA's statutory mandates suggests that Congress sought to impose substantive requirements on agency decision-making, and the legislative history preceding NEPA's enactment appears to support this position. For example, in response to what would eventually become NEPA's "action forcing" provisions in section 102, a Senate Report stated that "if [the] goals and principles [of the Act] are to be effective, they must be capable of being applied in action...[and the general policy directives of section 101] can be implemented if they are incorporated into the ongoing activities of the Federal Government [as required by section 102]" (Yost in Symposium 1990). Arguably, Congress intended that NEPA's broad policy mandates should be directly incorporated into agency decision-making, and that such decision-making should be subject to public and judicial scrutiny.

In an early leading case, Judge Skelly Wright appeared to support this congressional intent when he wrote that the Atomic Energy Commission (AEC) "seems to believe that the mere drafting and filing of papers is enough to satisfy NEPA" Calvert Cliffs Coordinating Comm., Inc. v. Atomic Energy Comm'n, 449 F.2d 1109 (D.C. Cir. 1971). Yet even then, Judge Wright's opinion castigating the AEC's regulations under NEPA contained language suggesting that NEPA was, at its core, a procedural mandate: "[t]he reviewing courts probably cannot reverse a substantive decision on the merits, under Section 101, unless it is shown that the actual balance of costs and benefits that was struck was arbitrary or clearly gave insufficient weight to environmental values."

Subsequent decisions have expanded on the procedural nature of NEPA. In Kleppe v. Sierra Club, 427 U.S. 390 (1976), the Supreme Court interpreted section 102 so as to "assure consideration" of environmental impacts by the agencies, and adopted a lower court's decision requiring that agencies need only take a "hard look" at environmental issues. Two years later, the Court declared that agency decision-making cannot be judicially overturned unless it is found to be "arbitrary and capricious" under the Administrative Procedure Act. Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, 435 U.S. 519 (1978).

Although the arbitrary and capricious standard for reviewing agency decisions appears to preserve the possibility of substantive review under NEPA (Yost in Symposium 1990), the Court has relied on Vermont Yankee for the proposition that "once an agency has made a decision subject to NEPA's procedural requirements, the only role for the court is to ensure that the agency has considered the environmental consequences." Strycker's Bay Neighborhood Council, Inc. v. Karlen, 444 U.S. 223 (1980).

This emphasis on NEPA's procedural nature — along with the concurrent minimization of NEPA's substantive requirements — has found further support in a recent Supreme Court decision, Robertson v. Methow Valley Citizens Council, 490 U.S. 332 (1989). There, the Court summarized the current judicial perspective on NEPA's mandates when it said that "[t]he sweeping policy goals announced in section 101...are thus realized through a set of "action forcing" procedures [in section 102] that require agencies to take a "hard look" at environmental consequences and that provide for broad dissemination of relevant environmental information." The Court went on to say that "NEPA merely prohibits uninformed — rather than unwise — agency action," and that NEPA relies on "procedural mechanisms" rather than "substantive result-based standards" to achieve its ends.

Thus, past and recent judicial opinions have relegated NEPA to what appears to be a purely procedural role, and the implications of this perspective for watershed protection are far-reaching: although a court may require an agency to consider impacts to watershed values when considering whether to move forward on a project, the courts will not substitute their judgment for the technical expertise of the agencies. In other words, if an agency determines that a project will cause adverse impacts to a watershed, yet still opts to proceed, the courts generally will defer to the agency's decision on the substantive merits of the proposed action if the agency compiles a sufficiently thorough EA or EIS.

As a result, NEPA stands apart from other environmental federal statutes: it does not attempt to designate any specific resource for heightened protection, as do the Wild and Scenic Rivers and the Endangered Species Acts, nor does its judicial interpretation provide a basis for substantive review of federal land management policymaking, as do the Multiple-Use, Sustained-Yield Act, the Federal Land Policy and Management Act, and the National Forest Management Act. Instead, NEPA requires federal agencies to consider the environmental implications of a proposed action, and in so doing, acts as an umbrella statute by forcing agencies to consider the environmental effects of proposed actions on federal lands as well as private actions subject to federal regulatory control under the Clean Water Act and other federal environmental laws, while also opening up the scope of these considerations to public and judicial scrutiny. Accordingly, after over twenty years, NEPA remains one of the more powerful levers in the federal statutory arsenal to enjoin activities which have received inadequate agency consideration regarding their environmental effects.

## 1.3. CUMULATIVE IMPACTS AND CONNECTED ACTIONS UNDER NEPA

### *1.3.1. Cumulative Impacts*

Judicial discussion of cumulative environmental impacts has been limited almost exclusively to NEPA caselaw. Although the Court in United States v. Alaska, 1992 U.S. LEXIS 2548, recently held that the Army Corps of Engineers may consider cumulative impacts when issuing permits under the Rivers and Harbors Act even if not expressly required to do so by statute, NEPA remains the primary vehicle for cumulative impacts analysis by the courts.

The CEQ's regulations under NEPA define cumulative impacts as:

> the impact on the environment which results from the incremental impact of the action when added to other past, present or reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 C.F.R. 1508.7).

Additionally, the regulations require that "cumulative actions," which are defined as actions "which when viewed with other proposed actions have cumulatively significant effects," be considered together in a single EIS (40 C.F.R. 1500.25).

Early in NEPA's history, the CEQ promulgated guidance which emphasized the importance of determining cumulative impacts when deciding whether a "major Federal action significantly [affects]...the quality of the human environment" (Thatcher in Symposium). Importantly, the regulations require agencies to assess and consider cumulative impacts not only from other federal activities, but also from non-federal and private ones. In Natural Resources Defense Council v. Callaway, 524 F.2d 79 (2d Cir. 1975), the court held that the Army Corps of Engineers violated NEPA in its proposal to dump dredged spoils off Connecticut on the grounds that the agency had failed to consider the cumulative impacts of other private and non-federal plans to dump spoils in that same area. Significantly, the court refused to allow the Corps to isolate the impacts of its dumping plan from the impacts of other dumping plans in the same geographical area.

In Sierra Club v. Kleppe, 427 U.S.390 (1976), the Supreme Court provided an opinion which "has bedeviled agencies, courts, and litigants trying to apply NEPA's cumulative impact obligation" (Thatcher in Symposium). There, the Department of the Interior (DOI) had prepared an EIS for coal leasing and mining in the Montana-Wyoming Powder River Coal Basin. The Sierra Club argued that DOI's proposed actions necessitated an EIS for the larger, coal rich Northern Great Plains region, since the foreseeable development of that larger region would necessarily affect cumulative impact analysis in the Powder River EIS. The lower court, while recognizing that NEPA only required EISs for "proposals" for major federal actions, nonetheless held that DOI should compile an EIS for the larger region.

The Supreme Court struck down the lower court's ruling, holding that an EIS is only required for concrete "proposals" of major federal actions. In interpreting the CEQ regulations then in effect, the Court ruled that only actions actually proposed, and not those merely "contemplated," need be considered within the scope of cumulative impacts analysis. Essentially, the Court gave substantial deference to DOI's determinations regarding the regions and ranges of proposals to be encompassed by an EIS. As Terence Thatcher noted "[b]y allowing the cumulative impacts of contemplated actions to be evaluated later, the Court seemed to endorse the kind of piece-meal analysis that Congress earlier criticized."

In a subsequent case, the court in Fritiofson v. Alexander, 772 F.2d 1225 (5th Cir. 1985), held that the Army Corps need not consider the reasonably foreseeable development of sensitive wetland areas on West Galveston Island in Texas when issuing a permit to develop a single tract of land. Although the tone of the opinion suggests that the court was sensitive to the broad mandates enunciated in the CEQ regulations, the Court's reliance on Kleppe produced a ruling focusing again on concrete proposals.

As a result of the above opinions, much confusion exists over whether an agency has formally proposed an action. According to the CEQ regulations, a proposal exists "at the stage in the development of an action when an agency...has a goal and is actively preparing to make a decision on one or more alternative means of accomplishing that goal and the effects can be meaningfully evaluated" (40 C.F.R. 1508.23). Although some courts have gone beyond Kleppe to expand the definition of a proposal, see e.g., National Wildlife Service v. U.S. Forest Service, 592 F. Supp. 931 (D. Or. 1984), vacated on other grounds, 801 F.2d 360 (9th Cir. 1986) (requiring a single EIS for a timber sale plan covering 75 individual sales), one basic rule apparently flows from the above cases: if a court finds a proposal, it will require that all its parts be assessed in one EIS (Thatcher in Symposium). However, if a court rules that a proposal does not exist, an EIS may still be required under the concept of "connected actions."

### *1.3.2. Connected Actions*

Under the CEQ regulations, "connected actions" are actions which are "closely related and therefore should be discussed in the same impact statement" (40 C.F.R. 1500.25). Actions are deemed "connected" if they: 1) automatically trigger other actions which may require environmental impact statements; 2) cannot or will not proceed unless other actions are taken previously or simultaneously; or 3) are interdependent parts of a larger action and depend on the larger action for their justification.

In Thomas v. Peterson, 753 F.2d 754 (9th Cir. 1985), the court considered a Forest Service EA which found no significant impacts would arise from the construction of a forest road. Plaintiffs argued that the Forest Service had failed to adequately consider, among other things, the adverse effects on water quality which would result from the timber cutting that naturally would follow the road construction. The court agreed that the road construction and the timber harvesting were connected actions under the CEQ regulations — despite the fact that no formal proposal had been made to cut trees — and ordered the Forest Service to consider both actions together in its supplemental EA.

## 1.4. CONCLUSION

Cumulative impacts analysis under NEPA may have important ramifications for watershed protection, since it requires agencies to assess and consider a broad range of actual and potential environmental effects expected to flow from agency decisions. Admittedly, judicial interpretation of cumulative impacts analyses has focused more on whether such analyses are required, and not so much on their substantive accuracy. Nonetheless, the fact that agencies must engage in such studies is important — if for no other reason than the effects such a requirement can have on an agency's ultimate decisions.

Judicial scrutiny of cumulative impacts on watershed values has been limited. However, encouragement can be found in Sierra Club v. Penfold, 857 F.2d 1307 (9th Cir. 1988), which upheld a lower court's injunction on placer mining in the Birch Creek, Beaver Creek, Fortymile River and Minto Flats watersheds in Alaska until the Bureau of Land Management (BLM) adequately completed cumulative impacts assessments for the areas. While the court acknowledged that the injunction could be lifted upon the completion of adequate impact studies, the case illustrates that watershed protection can be achieved—or at least better understood — under NEPA cumulative analysis review.

Another interesting point can be gleaned from Sierra Club. In arguing for a more comprehensive cumulative impacts assessment, plaintiffs pointed to the inevitable effects mining would have on Native American subsistence rights in one of the watersheds. This focus on a "target resource"— whether it be a wildlife species, a watershed or a recreational use — may hold particular promise for influencing courts during their consideration of cumulative impacts analyses (Thatcher in Symposium). For example, in Natural Resources Defense Council v. Hodel, 865 F.2d 288 (D.C. Cir. 1988) the plaintiffs focused on the cumulative impacts on whales and salmon which would flow from the Mineral Management Service's (MMS) proposal to explore and drill for oil in the Pacific Ocean. By focusing on target species whose migratory patterns would bring them into contact with activities ranging from Alaska to southern California, the plaintiffs were able to persuade the court that the MMS's EIS was legally deficient. As illustrated by Sierra Club, such resource target-specific strategies can work for watershed protection, whether arguments are based on watershed values as a whole, or on particular sub-watershed classifications, such as water quality, soil retention or species diversity.

Finally, it is important to remember that courts today construe NEPA as primarily a procedural statutory directive: although a court may force an agency to consider various environmental impacts related to a proposed action, the courts are reluctant to question the agencies" technical expertise. While there is a fine line between a court's determining the legal adequacy of an EIS and actually replacing an agency's substantive decisionmaking policies, the fact remains under NEPA that agencies can proceed with their proposals if they show they've considered all practical impacts and alternatives of a proposed action.

# 2. WATERSHEDS UNDER THE CLEAN WATER ACT

## 2.1. Background

The Clean Water Act (CWA) is the primary federal vehicle for protecting water quality in the United States. Since its creation in 1972, the CWA has focused primarily on controlling point sources of pollution to achieve its goals of zero pollution discharge and fishable and swimmable waters. Under the CWA, point sources are defined as "any discernible, confined and discrete conveyance, including...any pipe, ditch [or] channel..., from which pollutants are or may be discharged" 33 U.S.C. 1362(14). Because point sources are easily identified and are amenable to end-of-pipe waste treatment controls, the Environmental Protection Agency (EPA) and the states have been reasonably successful in regulating point source pollution.

However, as the control of point source discharges has improved, it has become increasingly clear that effective controls on non-point sources (NPS) are necessary to fulfill the CWA's lofty mandates. In 1987, EPA reported that of the total polluted surface waters in the United States, NPS were responsible for 76% of lake pollution, 65% of stream pollution, and 45% of estuary pollution (EPA 1987), and today, between 30-50% of the Nation's waters fail to meet applicable water quality standards. (ORC Draft 1992). In Oregon, NPS pollution from urban run-off and agricultural and silvicultural activities is responsible for approximately 60-70% of the state's water pollution (Fentress 1989).

To understand why, after twenty years under the CWA, NPS pollution continues to plague our nation's waters, it is helpful to look at how water quality regulation has evolved in the U.S. Prior to 1972, Congress relied primarily on a water quality based approach to regulate pollution discharges. Under that approach, ambient water quality standards were to be established within receiving waters, at levels which would protect certain uses of the waterbody — for example, fishing, swimming or industrial use. Thus, the water quality approach allowed dischargers to pollute to the extent that water quality standards were not violated and designated uses of the waterbody were not disrupted.

However, establishing water quality standards for all of the Nation's navigable waters proved overly burdensome due to a lack of resources, incentives, technical information and understanding. In 1972, Congress recognized the need for greater water pollution controls, and responded by shifting the regulatory emphasis of pollution control from the ambient water quality approach to a technology-based, effluent limitations approach. Under the CWA's National Pollutant Discharge Elimination System (NPDES), EPA received authority to issue discharge permits containing effluent limitations for specific pollutants. Simply put, effluent limitations define the amount of pollution allowed under a permit based on available treatment technologies. Importantly, no one may discharge a pollutant from a point source without a permit.

Yet despite Congress' shift to a technology-based approach, it recognized the merits of a water quality approach, and retained the latter's objectives to create a two-tiered regulatory structure. In short, if a discharger abides by his permit limitations, and yet the receiving water is still violating its water quality standard, then EPA, the states or even citizens can move to have the discharger's permit modified to protect the water quality.

This dual regulatory approach is particularly important with respect to NPS pollution. Because the CWA's enforceable effluent limitations apply only to point sources, NPS discharges typically escape regulation under the CWA. However, because water quality is still a primary objective of the CWA, approaching the NPS problem from a water quality angle appears to be the best if not only way to control NPS pollution under federal law. While EPA and the states still face the same daunting task of calculating and implementing water quality based controls that hindered the pre-1972 water quality approach, increased information, understanding and resources are paving the way for effective water quality based management of NPS.

### 2.2. An Early Recognition of NPS Problems: Section 208

Despite the heightened attention NPS pollution receives today, NPS problems are not new. Twenty years ago, Congress illustrated its concern with NPS pollution in section 208 of the CWA, codified as amended at 33 U.S.C. § 1288, by asking states to prepare comprehensive, areawide waste treatment management plans. The plans were to include measures for identifying NPS pollution from a variety of sources, and methods and procedures — including land use controls —t o abate NPS pollution. These plans were to be developed with the help of EPA NPS guidance, required under CWA section 304(f). Importantly, the plans were to be developed on an "areawide" basis, leading many states to consider NPS problems on a watershed level.

Yet while section 208 was an important step in getting states to recognize their NPS responsibilities, the program has been criticized, most notably for its lack of enforcement power. Although EPA has authority under the CWA to impose civil and criminal penalties for point source violations, EPA doesn't possess the authority to compel states to submit section 208 plans.

### 2.3. The Water Quality Act of 1987 and Section 319

Congress responded to section 208's shortcomings in the Water Quality Act (WQA) of 1987 by adding a new goal to the CWA's national policy provisions:

> [I]t is the national policy that programs for the control of non-point sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of [the CWA] to be met through the control of both point and non-point sources of pollution.

The WQA also created a new section 319 in the CWA, which required states to prepare assessment reports to identify areas with NPS problems, to enumerate the categories of NPS pollution, to list the processes by which states would identify the best management practices (BMPs) needed to control NPS pollution, and to discuss the state and local programs available or necessary to improve water quality through NPS controls. Section 319 also required states to develop management programs to document how and when states would address their NPS problems. To facilitate state efforts to develop the reports and plans, section 319 provided states with various financial incentives, and EPA issued a national NPS guidance document (EPA 1987). As a result, all states currently have approved NPS assessment reports, and most have approved management programs. Under CWA §518, several Native American tribes have prepared or are currently preparing §319 reports and programs for reservation lands.

Yet despite the existence of approved state and tribal NPS reports and programs, the lack of EPA authority to enforce section 319 goals has led some to criticize the program as simply an extension of section 208 (Pedersen 1988). Because NPS controls typically require modifications in land uses, many believe that sections 208 and 319 are ineffective because Congress is wary about intruding into areas of law — such as land use planning — which are typically reserved for states and localities. Senate Majority Leader George Mitchell illustrated this congressional deference during debates on the WQA, when he said that section 319 "does not provide for Federal intervention in State and Local planning decisions," that it does not "direct" states to adopt enforceable NPS regulatory programs, and that "[i]f a State decides it does not want a program to control non-point source pollution, that is it" (133 Cong. Rec. S. 1698 (daily ed. Feb. 4, 1987)).

Nonetheless, the WQA Amendments do provide some notable advancements for NPS controls. Significantly, section 319 contains a federal consistency provision similar to that found in the Coastal Zone Management Act, which requires states to review federal financial assistance and development programs to ensure that they comply with state NPS management programs. Additionally, section 319 emphasizes ground water protection in the identification of BMPs, and provides additional funding for ground water management.

Importantly, section 319 focuses on a holistic approach to NPS management, by requiring states to develop NPS controls on a watershed by watershed basis. Although EPA has yet to promulgate regulations under section 319, and the legislative history surrounding section 319 is virtually silent on the watershed NPS approach, EPA now has committed resources toward promoting a holistic, Watershed Protection Approach (WPA) to control NPS pollution (EPA 1991; EPA News-Notes #21, 1992). This watershed approach may be incorporated into state water quality management plans to facilitate a more coordinated management scheme for addressing both point and non-point sources. Many states and affected interest groups have responded to EPA's watershed agenda, and rapid advancements in water quality understanding and management — on a watershed basis — are forcing new strategies that will shape water pollution control into the next century.

## 2.4. EPA'S WATERSHED PROTECTION APPROACH

In October 1991, EPA's Office of Wetlands, Oceans and Watersheds released a finalized document entitled "The Watershed Approach (WPA) Framework Document" (EPA 1991b). The document positively reflects EPA's expanding commitment to address water quality problems in a comprehensive, holistic fashion, and with sufficient resources and coordination, the WPA could play an important role in protecting watershed values.

The WPA recognizes that past and current efforts focusing on water quality have fallen short for several reasons, including failing to address overall ecological and habitat health, neglecting to consider cumulative impacts from different types and sources of pollution, and not taking the opportunity to involve all levels of government in cooperative decision-making.

In response to these and other recognized short-comings, the WPA establishes three central goals. The primary goal is to reorient EPA and other federal, state and local programs to address watershed protection in a holistic manner. This goal would encourage state and local governments to establish and meet specific point and non-point source goals in target watersheds based on human health and ecological risk assessments.

The WPA's second goal would complement the first, with EPA promoting watershed coordination efforts among the various levels of government involved. This would involve developing and sharing technical resources, fostering the integration of federal, state and local management schemes, and providing support for local governments.

The third goal summarizes the direction of the WPA, and states that it will empower all levels of government to implement watershed-specific management plans; encourage consideration of cumulative chemical, biological and physical effects throughout the watershed; enhance coordination among interested parties; and enable states and EPA to assess progress by developing finite goals and milestones.

EPA will attempt to realize these goals by embarking on a two-pronged implementation approach. In the short term, EPA will manage regional watershed projects in areas where risk-based targeting suggests the strongest need. These watershed protection projects (WPP) form the core of EPA's WPA, and involve a broad array of information gathering and dissemination, multi-program integration, ecological and health assessment and coordinated program implementation within specific watersheds. Importantly, each WPP will contain distinct schedules for implementation, which will prove valuable in gauging the overall success/failure of each WPP. Additionally, within each WPP, EPA will assign a "champion" to coordinate and execute all levels of information gathering, planning and implementation for EPA in that watershed.

In the long term, EPA will attempt to effect institutional changes among the various layers of involved governments by enhancing statewide assessment and geographic targeting programs; focusing relevant agency attentions on targeted watersheds; involving public participation in developing comprehensive watershed plans; and working with the appropriate groups to develop continuing educational programs. A fundamental step in implementation will occur when EPA Regional Offices submit to EPA Headquarters their "comprehensive Regional Framework[s] for Action." These documents should give the Regional Coordinators firm footing to move forward on their WPPs for targeted watersheds.

Despite the inherent technical, logistical and legal difficulties in attacking water quality problems at the watershed level, EPA appears firmly committed to meeting the task head-on. With sufficient funding and continued commitment, the WPA could prove to be an effective program for protecting watersheds. However, while EPA coordination and technical support are essential to the success of any integrated watershed approach, the fact remains that without mandatory programs aimed at controlling imprudent land management patterns and their resulting NPS run-off, a watershed approach will almost certainly fail to effectively attain and preserve water quality within a basin.

Thus, in the course of the WPA implementation, EPA should make every effort to persuade state and local governments of the importance of installing regulatory programs aimed at combating NPS pollution. These programs could come in various forms, ranging from a straight mandatory regulatory approach, to an incentive/disincentive approach aimed at individual landowners or specific categories of land uses, to a polluter-pays tax. Admittedly, such efforts will be met with opposition, but without them, the potential benefits of a watershed approach could fall prey to the same indifference and noncompliance which have plagued the EPA's current voluntary compliance/cooperative management non-point source agenda.

### 2.5. Alternative NPS Controls Within the CWA: TMDLs, Water Quality Standards and the Water Quality Approach

The CWA gives the states primary authority to set water quality standards "to restore and maintain the chemical, physical and biological integrity of the Nation's waters." While the standard setting process is quite complex, the general purpose of these standards is to protect the range of uses which have been designated to a waterbody — for example, protection of fish and aquatic life, protection of public drinking water supplies, etc.

Water quality standards form the primary legal authority for controlling NPS pollution. Unlike point sources, which are subject to mandatory effluent limitations that are technology-based, controls on NPS pollution (such as BMPs) are not mandatory under the CWA, and thus NPS controls must be based on the CWA mandate to meet water quality standards. This reliance on the water quality approach to address NPS pollution under the CWA will continue unless Congress or the states require certain mandatory controls on NPS sources.

Yet while the water quality approach appears sound in theory, in practice it is quite difficult to implement. Under the CWA, states must identify all waters for which technology-based effluent controls on point sources are not enough to ensure compliance with water quality standards. Then, states must calculate a total maximum daily load (TMDL) for each waterbody failing to meet its water quality standards.

To understand the TMDL process, it is necessary to know a few basic terms and concepts: "Loading Capacity" is the maximum amount of a pollutant a waterbody can receive without violating its water quality standard for that pollutant; "Waste Load Allocation" (WLA) is the portion of the loading capacity to be allocated to point sources; and "Load Allocation" (LA) is the portion of the loading capacity to be allocated to non-point and background sources. Because the TMDL is the maximum daily amount of a pollutant which can be discharged without exceeding a waterbody's loading capacity with a factor of safety, the TMDL is equal to the sum of all WLAs and LAs. In other words, NPS pollutants plus background pollutants (LAs), plus point source pollutants (WLAs), can never exceed the receiving water's TMDL (Thompson 1989).

There are practical and logistical problems with establishing water quality standards and TMDLs. For example, if a specific stream segment is violating its water quality standard for bacteria, the state must determine how much bacteria the stream can naturally assimilate before it exceeds the standard (Loading Capacity), then it must attempt to locate all point and non-point sources of bacteria that affect the stream (typically all sources within the watershed) and allocate limitations on the amount of bacteria they individually may discharge without violating the TMDL (WLAs plus LAs). As a result of financial and technical restrictions, few states have water quality standards for traditional NPS pollutants — such as pesticides and nutrients — and even fewer have attempted to calculate TMDLs for NPS pollutants. One notable exception is Oregon, where the state entered a consent decree on June 3, 1987 to calculate TMDLs for phosphorus and ammonia for the Tualatin and ten other Oregon rivers. Significantly, EPA has made a strong commitment toward helping states establish TMDLs (EPA News-Notes #21, 1992), and as monitoring information and implementation programs improve, the importance of TMDLs in regulating NPS will continue to grow.

Another potentially important section of the CWA regarding NPS and water quality involves EPA's "antidegradation" policy, under which states must act to ensure that all "existing instream uses" must be "maintained and protected." (40 C.F.R. 130.12). This policy requires states to ensure that both point and non-point discharges will not degrade the uses of a waterbody below the levels for which it was designated — for example, if a river has a designated use of fishing, the state must ensure that use is preserved by limiting discharges. Unfortunately, EPA has only recently begun to focus on its antidegradation policy, and states have been slow in responding. (ORC Draft 1992).

## 2.6. Litigation Involving NPS Pollution

Few courts have been presented with the issue of enforcing water quality standards against NPS discharges. In Northwest Indian Cemetery Protective Ass'n v. Peterson, 565 F. Supp. 586 (N.D.Cal. 1983), aff'd in relevant part, 795 F.2d 688 (9th Cir. 1986), the court ruled that timber harvesting in the Chimney Rock section of the Six Rivers National Forest in California would violate the CWA by exceeding the turbidity and suspended solids water quality standards established by the state.

However, subsequent decisions by the same court illustrate that this area of law is not particularly well settled. In Oregon Natural Resources Council v. U.S. Forest Service 834 F.2d 842 (9th Cir. 1987), the court refused to enforce water quality standards against a proposed logging operation, stating that "it is not the water quality standards themselves that are enforceable [under the CWA], but it is the "limitations necessary to meet" those standards" which are enforceable. Thus, because the CWA does not contain any mandatory, technology-based standards on non-point sources — BMPs are strictly discretionary under sections 208 and 319 — the court effectively ruled that citizens could not enforce the CWA to prevent NPS discharges which caused violations of water quality standards.

Yet while the ONRC v. USFS decision appears to be a substantial setback to groups attempting to preserve water quality from NPS discharges under the CWA, the decision in Oregon Natural Resources Council v. Lyng, 882 F.2d 1417 (9th Cir. 1989) contains language which suggests that NPS dischargers can be found in violation of state water quality standards. The appeals court refused to overturn the lower court's determination that a proposed timber sale in the Hell's Canyon National Recreation Area would not violate Oregon water quality standards. The issue wasn't whether a NPS discharge could be found to violate a water quality standard, but whether the ONRC had supplied enough proof to show that a violation would actually occur. Importantly, the court did not reject outright ONRC's argument that NPS discharges from timber operations could violate water quality standards, but instead focused on whether ONRC had proved that the violations would in fact occur. The court said "[p]roper implementation of state-approved BMPs will constitute compliance with the CWA unless water quality monitoring reveals that the BMPs have permitted violation of...water quality standards." Because the requisite proof was lacking, the court allowed the sale, but the tone of the opinion suggests that NPS dischargers can be held accountable under the CWA for violations of water quality standards. Despite the ambiguity of the above decisions, water quality enforcement appears to be the best avenue for legally controlling NPS discharges, particularly on federal lands as discussed further below.

## 2.7. SECTION 404 WETLANDS REGULATION AND THE WATERSHED APPROACH

Wetlands serve a variety of important functions in maintaining, preserving, and controlling water quality and quantity, and as a result, play an important role in protecting watershed values. Wetlands provide habitat for a variety of fish, shellfish, and wildlife, improve water quality and combat sedimentation by acting as natural filtration systems, recharge groundwater supplies through natural percolation, act as storm buffers and flood controls for vulnerable upland areas, and provide numerous recreational, aesthetic, and scientific values.

Yet despite the important roles wetlands play, the U.S. Fish and Wildlife Service estimates that at least 53% of the wetlands in the lower 48 states have been destroyed within the last 200 years (Dahl 1990). And despite the presence of section 404 of the Clean Water Act, 33 U.S.C. § 1344, and other wetland protection statutes (for example, the Estuarine Areas Protection Act, the Coastal Zone Management Act, the Coastal Barrier Resources Act, the Fish and Wildlife Coordination Act, and the swampbuster and other provisions in the 1985 and 1990 Farm Bills), current estimates for wetlands losses range from 200,000 to 500,000 acres per year (Dahl 1990).

Section 404 of the CWA establishes a permit system to regulate the dredging and filling of the Nation's navigable waters. Several important court decisions, including Natural Resources Defense Council v. Calloway, 392 F. Supp. 685 (D.D.C. 1975), and United States v. Riverside Bayview Homes, 474 U.S. 121 (1985), expanded the federal government's jurisdiction over navigable waters as including fresh and saltwater wetlands, mudflats, sloughs, and other traditionally non-navigable areas. As a result, section 404 is the primary wetlands protection law in the United States. Unfortunately, as the wetlands figures above suggest, section 404 and related statutes have been less than perfect in protecting and managing the nation's wetlands.

### *2.7.1. Wetlands Delineation*

Defining exactly what constitutes a wetland has been a source of heated political and scientific controversy, particularly since President Bush's 1988 campaign promise of "No Net Loss to Wetlands." Prior to 1989, the four federal agencies with jurisdiction over wetlands —

the Army Corps of Engineers (COE), the Environmental Protection Agency (EPA), the Soil Conservation Service (SCS) and the Fish and Wildlife Service (FWS) —each had their own definitions and methods for delineating wetlands. However, after ten years of interagency negotiation and cooperation, the agencies jointly adopted the Federal Manual for Identifying and Delineating Jurisdictional Wetlands in January 1989. The 1989 Manual attempts to standardize the delineation of wetlands in the field by establishing three criteria for designating wetlands areas — hydrophytic vegetation, hydric soils, and wetlands hydrology (Zinn & Copeland 1991).

While the 1989 Manual represented a compromise between conservative COE wetlands definition and a more liberal FWS definition, it came under immediate attack from real estate, agriculture, mineral, and oil and gas interests because it greatly expanded the COE's jurisdiction over wetlands from about 100 million acres to over 200 million acres in the continental U.S. (Corday 1991). As a result of the intense political pressure surrounding the 1989 Manual, EPA published a proposal for a new manual in August 1991 (56 Fed. Reg. 40,446 (1991), which sought to reduce the COE's 1989 wetlands jurisdiction by up to 50%.

While EPA's proposal may have appeased some of the industry interests which had lobbied for change, it stirred a frenzy of lobbying by environmental groups and prompted numerous hearings on Capitol Hill regarding wetlands science, functions, and values. In fact, many have fingered section 404 wetlands delineation as a primary factor in thwarting reauthorization of the Clean Water Act during the last Congress. However, the most mischievous blow came on August 17, 1991, when the House of Representatives passed an appropriations bill (HR 2427; Pub. L. No. 102-104) which prohibited the COE from using monies to implement the 1989 Manual. As a result, the COE must now rely on its own 1987 Manual to delineate wetlands until a new manual is devised, while the other three agencies (for example, EPA, SCS, FWS) continue to use the 1989 Manual. The Clinton administration has proposed consolidation and greater coordination in the administration of the 404 program while continuing to honor a "no net loss" policy.

### *2.7.2. The Section 404 Permitting Process*

Congress gave the COE primary authority over section 404 because the COE was already administering a waterway obstruction permitting program under section 10 of the Rivers and Harbors Act, 33 U.S.C. § 403 (Corday 1991). Because the COE is a highly decentralized agency, its section 404 program management is delegated to its 36 district and 11 division engineers (ORC 1991), who are responsible for processing about 15,000 individual permits each year (Zinn & Copeland 1991). About 10,000 of these individual permit applications are issued, about 500 are denied, and the remaining 4,500 are canceled by the COE, withdrawn by the applicant, qualify for exemption or fall under a general permit.

Under the current permitting process, the COE makes initial findings on permit requests to determine whether the proposed activity constitutes a "discharge," for example, whether it will convert saturated or aquatic land to dry land by changing bottom elevations (33 C.F.R. 323.2(e)). Because the regulatory definition of such a conversion is so narrow — only "discharges" of "dredge and fill material" into U.S. "waters" resulting in "conversions" require permits — countless acres of wetlands continue to be lost due to draining, dredging, hole digging, and channeling activities which fall beyond current regulatory boundaries (GAO 1991).

If the proposed activity requires a permit, the COE district engineer conducts a "public interest review," in which she/he opens the process to public comment, and weighs the benefits of the proposal against its reasonably foreseeable adverse impacts (33 C.F.R. 320.4(a)(1)). This balancing test requires the COE to consider not only economic and aesthetic factors, but also the proposal's potential effects on wetlands, fish and wildlife values, historic properties, land use, navigation, recreation, flood plains, energy needs, and, importantly, water quality.

According to COE regulations, the COE's decision "should reflect the national concern for both protection and utilization of important resources" and "[n]o permit will be granted...unless the district engineer concludes...that the benefits of the proposed project outweigh the damage to the wetlands resource" (33 C.F.R. 320.4). Thus, in most cases, a permit will be granted unless the district engineer finds it contrary to the public interest. The ORC has criticized this aspect of the COE's decentralized decisionmaking, stating that a public interest determination is "a rather lofty determination for a district engineer to make" (ORC 1992).

Although Congress delegated to the COE the primary responsibilities for administering the section 404 permit program, it recognized the COE's historical tendencies favoring wetlands development (Corday 1991). As a result, Congress gave EPA the power to veto COE permit approvals which could be shown, after public notice and comment, to have "an unacceptable adverse effect" on wetlands (33 U.S.C. § 1344(c); 40 C.F.R. 231.2(e)). While the EPA's veto authority has been upheld by the courts, see, for example, Bersani v. Environmental Protection Agency, 850 F. 2d 36 (2d Cir. 1988), cert. denied, 489 U.S. 1089, 109 S.Ct. 1556 (1989), EPA had vetoed only seven permit decisions nationwide as of 1991 (Corday 1991).

Additionally, pursuant to the Fish and Wildlife Coordination Act, 16 U.S.C. § 662 et. seq., the COE must consult with the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS) before issuing a permit, and give full consideration to the comments and suggestions from these agencies when deciding whether a permit should be issued (33 C.F.R. 320.4(c)).

States may also play a significant role in wetlands determinations. For example, a state may assume responsibility for wetlands permitting in areas not subject to traditional federal tests for navigability (that is, those areas not suitable for interstate or foreign commerce) (33 U.S.C. § 1342(h)). Also, under section 401 of the CWA discussed below, the COE must receive a certification from the state that the proposed permit will not violate, among other things, state water quality standards, before a permit may be issued. Furthermore, if a state has an approved coastal zone management plan under the Coastal Zone Management Act, then the state can object to a permit, and the COE's only recourse is to appeal the objection to the Secretary of Commerce (16 U.S.C. § 1456(c)).

In addition to these safeguards, Congress also required the COE to adhere to EPA permit issuance guidelines in the COE's public interest review process (33 U.S.C. § 1344 (b)). These guidelines set out four primary criteria. First, no permit may be issued "if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic system" (33 C.F.R. 230.10(a)). As illustrated by the court in Friends of the Earth v. Hintz, 800 F.2d 822 (9th Cir. 1986), the COE has broad discretion in determining what is a "practicable alternative," and may consider such factors as costs and existing technology when making its determination (33 C.F.R. 230.10(a)). And according to a 1988 GAO report, the COE rarely relies on the "practicable alternatives" test as the sole basis for rejecting an application, apparently because COE places undue emphasis on what is reasonably practicable from the perspective of an applicant (GAO 1988).

The second EPA criterion states that "no discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of waters" of the U.S. (33 C.F.R. 230.10(c)). Third, no discharge shall be permitted if it contributes to a violation of a state water quality standard, violates toxic effluents standards, jeopardizes an endangered species or violates the Marine Mammal Protection Act (33 C.F.R. 230.10(b)). Lastly, "no discharge...shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts...on the aquatic system" (33 C.F.R. at 230.10(d)).

Yet despite the apparently restrictive language in the EPA guidelines, COE retains considerable latitude on interpreting and implementing them. For example, the COE has not developed a consistent, program-wide approach to calculating cumulative impacts, although such analysis would appear to lie at the heart of at least three of the four criteria outlined in the EPA guidelines. As the GAO points out, the COE's reliance on case-by-case cumulative impacts determinations has resulted in significant disparities in wetlands delineations and permit approvals (GAO 1988). These disparities, coupled with GAO's finding that the water quality goals of the CWA are often compromised under section 404 as a result of COE's focus on short-term rather than long-term interests, do not provide encouragement for a comprehensive watershed-type approach under the current program (GAO 1988).

Thus, as a result of the COE's broad discretionary powers, the COE approves the vast majority of the 15,000 annual individual permit applications it receives. And despite the fact that the COE typically includes environmental safeguards in many of its permit approvals, the fact remains that most techniques to mitigate the adverse impacts of wetlands development are scientifically questionable (Zinn & Copeland 1991). Despite a 1990 Memorandum of Agreement between the COE and EPA clarifying the specific sequence of actions necessary to mitigate adverse impacts in section 404 proposals, the feasibility of applying this sequencing approach within a viable "no net loss" agenda has yet to be proven (Zinn & Copeland).

Accordingly, the COE's administration of the section 404 individual permit program continues to allow the loss of our Nation's wetlands, and using the current section 404 individual permit program to preserve water quality through a watershed approach would be unlikely to succeed.

### *2.7.3. The General Permit Program*

The 1977 amendments to the CWA authorize the COE to issue general permits for activities that are similar in nature which will cause only minor individual and cumulative adverse impacts (33 U.S.C. § 1344(e)). These permits may be issued on a national, regional or statewide basis, after public notice and comment.

Currently, the COE has 26 nationwide permits (see 33 C.F.R. 330.5(a) for listings), 22 of which do not require landowners to inform the COE of their activities as long as they comply with various conditions (that is, no discharges near public water supply intakes; no discharge of toxics) and management practices (that is, no discharges in spawning areas) required of all general permits. Some of the activities authorized under general permits include the placement of navigational aids, bridge building, and construction of fisheries spawning and harvesting devices (ORC 1992).

One of the most controversial general permits, dubbed the "isolated wetlands" permit, allows discharges into wetlands which are smaller than ten acres in size, and which are located above the headwaters (for example, waters with an average annual flow rate less than five cubic feet per second) of non-tidal (or "isolated") waters (33 C.F.R. 330.2(b)). As ORC notes, the determination of where a discharge takes place is significant, since a discharge above the headwaters may not require an individual permit, while the same discharge at a lower point on the river may (ORC 1992). Since an estimated 17 million acres of wetlands are affected each year by the "isolated wetlands" permit, the headwaters distinction is obviously important.

### *2.7.4. Section 404 Statutory Exemptions*

In the 1977 amendments to the CWA, Congress provided six distinct exemptions from the section 404 permit program. Under section 404(f), these exemptions are for:

1) normal farming, silviculture, and ranching activities;
2) emergency reconstruction and general maintenance of dikes, dams, causeways, bridges, breakwaters, and transportation structures;
3) construction or maintenance of farm or stock ponds, or irrigation ditches;
4) temporary sedimentation basins on construction sites;
5) construction and maintenance of farm and forest roads, or temporary roads for moving mining equipment, so long as aquatic impacts are minimized; and
6) discharges with respect to any activity for which a state has an approved section 208 areawide waste management treatment plan.

As their language suggests, these exemptions operate to remove a substantial amount of otherwise regulatable activity from the mandates of section 404. However, Congress recognized the broad loophole it was creating with section 404(f), and responded by subjecting all such exemptions to a "recapture clause," which essentially limits the exemptions to specific activities which had either 1) been on-going at the time the amendments were passed; or 2) which would not interfere with the flow, circulation, or reach of navigable waters (for example, have negligible impacts).

As a result of the recapture provision, the courts have generally construed the exemptions narrowly, see for example, United States v. Akers, 785 F.2d 814 (9th Cir. 1986), and United States v. Larkins, 852 F.2d 189 (6th Cir. 1988), and typically will not allow activities which attempt to convert expansive wetlands areas, or which attempt to shift original land use activities (for example, harvesting wheat) to new types not in use at the time the amendments passed (for example, harvesting water-intensive salt hay). Despite the courts" restrictive interpretation of the recapture clause, these exemptions nonetheless operate to exclude many activities which adversely affect wetlands values and water quality (ORC 1992).

### 2.8. Section 401 and the State Certification Process

Under section 401 of the CWA, 33 U.S.C. § 1341, an applicant for a federal permit or license to conduct an activity that may result in a discharge to state waters must first obtain a certification from the state that such discharge will comply with the state's water quality standards and effluent limitations. Such activities may include hydropower licensing under authority of the Federal Energy Regulatory Committee (FERC), individual and general wetlands permitting under CWA section 404, and National Pollutant Discharge Elimination System (NPDES) permits for point source discharges under CWA section 402.

Section 401 is a potentially powerful tool for states pursuing a watershed-based water quality approach, because judicial review of state certification decisions begins in the state courts. The United States Supreme Court recently affirmed a Washington Supreme Court decision approving use of the 401 certification process to establish minimum stream flows. State v. PUD No. 1, 121 Wash. 2d 179, 849 P.2d 179, affirmed, 1994 West Law 223821 (May 31, 1994). The Oregon Supreme Court recently approved a similar use of the 401 certification process. City of Klamath Falls v. EQC, 3180 r. 532, 870 P. 2d 825 (1994).

## 3. FEDERAL SOIL CONSERVATION LAW

The problem of soil erosion resulting from agricultural practices has been recognized by the federal government since the 1935 creation of the Soil Conservation Service (SCS) and the 1936 creation of the Agricultural Stabilization and Conservation Service (ASCS) as part of the United States Department of Agriculture (USDA). The passage of the Food Security Act of 1985 (Public L. No. 99-198, codified at 16 U.S.C. § 3801-3845) included conservation measures: "the so-called sodbuster, swampbuster, conservation compliance, and conservation reserve programs" (Tabb and Malone 1992). These measures linked federal subsidies administered by the USDA with conservation measures also administered by the USDA. Although compliance with the conservation measures is still voluntary, a farmer who does not comply with the measures will not receive federal aid.

In 1990, Congress passed the "Conservation Program Improvements Act" which reauthorized the conservation provisions of the 1985 act and created new conservation provisions. The 1990 reauthorization "significantly amended the existing programs, expanding the scope of the conservation reserve program while broadening the exemptions in and weakening enforcement of the swampbuster and sodbuster programs" (Tabb & Malone 1992).

The sodbuster provision is a soil conservation measure requiring that farmers not put any highly erodible land into production without the implementation of a conservation plan. The provision applies to the production of "agricultural commodities" on land that was not in production between 1981 and 1985. For erodible land that was already in production between 1981 and 1985, full implementation of a conservation plan is to be underway by 1995. The swampbuster provision is aimed at conservation of wetlands by cutting off USDA price and income supports for "any person who produces an agricultural commodity on wetlands converted after December 23, 1985, or who, after December 23, 1990, converts a wetland by any means so as to make possible the production of an agricultural commodity on such converted wetland" (Tabb & Malone 1992). USDA and EPA regulations regarding prior converted wetlands can be found at 7 C.F.R. Part 12 and 40 C.F.R. Parts 110, 112, 116, 117, 122, 230, 232 and 401. The 1990 act included a provision which allows gradual sanctions on "good faith violators." See National Wildlife Federation v. Agricultural Stabilization Service, 955 F.2d 1199 (8th Cir. 1992).

The 1990 act also created the Environmental Easement Program. A landowner enters into a contract stipulating that he or she will not use the land for agricultural commodity production, but put the land toward "less intensive use" and apply conservation practices. The landowner must enter into the contract for no less than ten years, and no more than fifteen years. In exchange, the landowner receives "50% of the cost of establishing water quality and conservation measures...and annual rental payments to compensate for the retirement of the land during the period of the contract" (Tabb & Malone 1992). The conservation reserve program included more than 34 million acres (Center for Resource Economics 1991).

The Environmental Easement Program allows the Secretary of Agriculture to acquire easements on land placed in the conservation reserve, land under the Water Bank Act (16 U.S.C. § 1301), and any other cropland that contains riparian corridors, or critical habitat, or contains other environmentally sensitive areas. The landowner is responsible for implementing conservation measures on the easement, and may be eligible for up to 100% reimbursement for the cost of implementing the conservation measures. Further, the land in the easement may still be used for hunting and fishing (Tabb & Malone 1992).

Federal programs associated with the Soil Conservation Service and the Agricultural Stabilization and Conservation Service have the potential to fund watershed improvement programs at the state level. The Conservation Reserve Program and the Environmental Easement Programs under the 1990 act may be important parts of conserving and setting aside riparian areas. The Soil Conservation Service gives assistance to state and local watershed projects through the Small Watershed Program Grant (16 U.S.C. § 1001 et seq.; 33 U.S.C. § 701-1 and 42 U.S.C. 1962 et. seq.; 7 C.F.R. Parts 620 et seq. and 660). The Agricultural Stabilization and Conservation Service administers the Rural Clean Water Program, created by the 1977 amendments to the Clean Water Act, for "installing and maintaining measures incorporating best management practices to control non-point source pollution for improved water quality" (CWA § 208(j)(1), 33 U.S.C. § 1288(j)(1), 7 C.F.R. Parts 700 et seq.).

# 4. WATERSHED MANAGEMENT IN OREGON AND SELECTED OTHER STATES

## 4.1. INTRODUCTION

As a result of the mandates under Section 319 of the Clean Water Act and the 1990 reauthorization of the Coastal Zone Management Act — discussed in the next section — state water quality agencies are beginning to develop watershed-based water quality management programs. For example, as Oregon continues to develop its NPS pollution program, the Governor's Strategic Water Management Group is developing statewide watershed management guidelines.

This section focuses on state policies and management programs that seek to implement the federal Clean Water Act, as well as several proposed or recently established programs which address watershed management. Programs in Oregon, North Carolina, Washington, and Idaho that address NPS pollution and watershed management are reviewed.

## 4.2. DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

The Oregon Department of Environmental Quality (DEQ) is the state agency responsible for implementing the Clean Water Act (ORS 468.730). DEQ's efforts to control non-point sources (NPS) of pollution began under section 208 of the Clean Water Act. Under section 208, DEQ coordinated statewide studies of such non-point sources as "irrigation return flows, erosion in dry land wheat-farming areas, fecal-waste impacts on shellfishing, streambank erosion, groundwater pollution, and urban runoff" (DEQ 1991b). The section 208 studies resulted in the implementation of "control strategies" to reduce the non-point sources of pollution identified.

The Water Quality Act of 1987 amended the Clean Water Act to require that states "identif[y] those...waters within the [s]tate which, without additional action to control non-point sources of pollution, cannot reasonably be expected to attain or maintain applicable water quality standards or the goals and requirements of this Act" (Section 319, 33 U.S.C. 1329). The section 319 mandate resulted in the 1988 Oregon Statewide Assessment of Non-point Sources of Water Pollution, including the compilation of a computerized database "containing information about NPS-linked water quality on 28,000 miles of rivers and streams as well as in many lakes, estuaries, and bays, and shallow groundwater aquifers" (DEQ 1991b). DEQ also developed a Non-point Source Statewide Management Program for Oregon (DEQ 1991b).

DEQ's NPS implementation program is a pollution prevention program, with an emphasis on best management practices (BMPs) that can be put into place to avoid the creation of critical water quality problems in a water basin affected by a variety of non-point sources. Establishing a TMDL for a water basin or for a particular river can result in moratoriums on human pollution-causing activities in the watershed until pollution prevention measures are developed. The threat of an injunction on certain activities in a watershed may be a public incentive to assist in the development of and compliance with prevention measures in the form of best management practices.

The NPS Program includes a list of program strategies and objectives which "will be incorporated into interagency action plans" (DEQ 1991b). These include "monitoring, assessment, [and] evaluation" such as continuing the evaluation of waterbody and watershed conditions that started with the 1988 assessment. Other objectives include looking at cumulative effects through the TMDL approach under section 303 of the Clean Water Act. Riparian areas and wetlands are also part of the NPS program. DEQ also proposes to look into an ecoregion approach: "Although watersheds are the principal unit of geographic organization of the NPS program at present, the concept of ecoregions holds great potential for the development and application of BMPs, the refinement of water quality standards, and the future organization of NPS programs" (DEQ 1991b).

DEQ's 1988 non-point source inventory resulted in the identification of eleven different sources of NPS pollution: Range - 21.3%; Forestry - 17.4 %; Agriculture - 17.4%; Recreation - 13.8%; Natural - 9.7%; Mining - 5.2%; Transportation - 4.8%; Urban Storm Water - 3.8%; Construction - 3.3%; Municipal - 2.4%; Industrial - 0.8% (DEQ 1991b). DEQ categorized these sources into five land use groupings: agriculture, forestry, grazing and range management, urban development, and recreation. The management program includes an assessment of the "activities" encompassed by those land uses, the "contributions of that land use to statewide NPS-caused water quality problems...and the typical kinds of NPS pollution resulting from those land use practices" (DEQ 1991b). For each of the land use areas, designated management agencies work with DEQ to develop Best Management Practices. For example, the Oregon Department of Forestry is responsible for best management practices under the Oregon Forest Practices Act, discussed below.

DEQ also has performed an extensive study of the Coquille River basin with funding from the EPA's Near Coastal Waters Program. The "Action Plan for Oregon Estuary and Ocean Waters" was chosen as one of three pilot programs from around the country to demonstrate the management of water quality in coastal waters. The Coquille River basin has been designated by DEQ as a "Water Quality Limited" waterbody. The TMDL established for the Coquille does not include non-point sources, but DEQ has worked with other agencies to develop measures to reduce non-point sources of pollution into the Coquille (DEQ 1991a).

### 4.3. Soil Conservation

Soil and water conservation districts in the state are authorized by the legislature to conserve natural resources, including to "control and prevent soil erosion, control floods, conserve and develop water resources and water quality" and to work with "landowners, land occupiers, other natural resource users, other local government users" and state and federal agencies to carry out legislative policy (ORS 568.225(1),(2)). As a unit of local government in the state, soil and water conservation districts may seek approval from the Oregon Department of Agriculture to implement land use regulations to further the goals of soil conservation and erosion prevention (ORS 568.630).

A 1979 Iowa Supreme Court decision which may be persuasive in any challenges to the Oregon statute is Woodbury County Soil Conservation District v. Ortner, 279 N.W. 2d 276 (1979), which upheld an Iowa statute requiring private landowners to comply with provisions to prevent soil erosion. Ortner held that these regulations were not unconstitutional takings of private property but that they were within the police power of the state. The statutory regulations were found to be "reasonably related to carrying out the announced legislative purpose of soil control, admittedly a proper exercise of police power." Id. at 279. More recently, in Leroy Land Development v. The Tahoe Regional Planning Agency, 939 F. 2d 696, (9th Cir. 1991), a private land development corporation challenged the Tahoe Regional Planning Agency's requirement that in order to develop property off the shore of Lake Tahoe on-site and off-site mitigation measures would be required. The mitigation requirements were part of an earlier settlement between Leroy and TRPA for the granting of a building permit, and Leroy claimed the mitigation requirement was an unconstitutional taking. In holding that the mitigation requirement was not a taking, the Ninth Circuit cited the Supreme Court opinion in Nollan v. California Coastal Commission, 483 U.S. 825 (1987), which held that "a land-use regulation would not constitute a taking so long as it substantially advanced a legitimate state interest and did not deny the property owner economically viable use of the property." Id. at 698. The mitigation measures "would ameliorate erosion, destabilization and other adverse environmental effects caused by Leroy's development and thus directly further the governmental interest underlying the application of the relevant TRPA regulations to Leroy's development" Id. at 698. (1991). As these opinions indicate, because soil erosion control regulations typically allow reasonable land uses and do not cause physical intrusions by government or the public onto the land, they are not likely to be struck down as takings by state or federal courts applying the Supreme Court's recent decision in Lucas v. South Carolina Coastal Council, 112 S. Ct. 288 (1992), or its opinion in Kaiser-Aetna v. U.S., 444 U.S. 164 (1979).

## 4.4. Department of Land Conservation and Development (DLCD)

As authorized by the Oregon legislature (Oregon Revised Statutes Chapter 197), the Land Conservation and Development Commission (LCDC) has established a comprehensive statewide program of land-use planning. The 19 land use goals are implemented through the adoption of local comprehensive plans which must be consistent with the statewide goals. The Department of Land Conservation and Development (DLCD) reviews local plans for goal consistency. State agencies and special districts must comply with the statewide goals and must act consistently with LCDC approved local comprehensive plans.

Several of the goals incorporate water management into land use plans. Goal 5: Open Spaces, Scenic and Historic Areas, and Natural Resources, and Goal 6: Air, Water and Land Resources Quality, call for the incorporation of water resources into the comprehensive plans. Goal 5 directs local comprehensive plans to "conserve open space and protect natural and scenic resources." It also mandates inventory of the "location, quality and quantity" of resources such as "fish and wildlife areas and habitats," "potential and approved federal wild and scenic waterways and state scenic waterways," and "water areas, wetlands, watersheds, and groundwater resources."

Goal 6 may be important in looking at statewide watershed management in that it mandates that future development and existing development and land uses be coordinated to maintain water quality standards. Future development must be planned so that resulting wastes and discharges in combination with wastes and discharges of current development do not "threaten to violate, or violate" federal and state environmental quality standards. "With respect to the air, water, and land resources of the applicable air sheds and river basins described or included in state environmental quality statutes, rules, standards and implementation plans, such discharges shall not (1) exceed the carrying capacity of such resources, considering long range needs; (2) degrade such resources; or (3) threaten the availability of such resources."

Planning guidelines for Goal 6 include: "4. Plans should buffer and separate those land uses which create or lead to conflicting requirements and impacts on the air, water and land resources." Buffering techniques could include riparian protection and restoration, and zoning regulations which include riparian setback requirements. Another Goal 6 guideline recommends state and local agency coordination: "6. Plans of state agencies before they are adopted, should be coordinated with and reviewed by local agencies with respect to the impact of these plans on the air, water, and land resources in the planning area."

Goal 16 and 17 focus on the coast. Goal 16 mandates that local comprehensive plans "recognize and protect the unique environmental, economic, and social values of each estuary and associated wetlands; and to protect, maintain, where appropriate develop, and where appropriate restore the long-term environmental, economic and social values, diversity and benefits of Oregon's estuaries." Goal 17: Coastal Shorelands, includes the "management of these shoreland areas"...."[be] compatible with the characteristics of the adjacent coastal waters...." "Shoreline" is defined as "the boundary line between a body of water and the land, measured on tidal waters at mean high, high water, and on non-tidal waterways at the ordinary high-water mark."

### 4.5. Department of Fish and Wildlife (ODFW)

Oregon Administrative Rules, Chapter 635, Division 415 contains rules implementing the Fish and Wildlife Habitat Mitigation Policy of the Department of Fish and Wildlife. The Habitat Mitigation Policy supports the Oregon Wildlife Policy, ORS 496.012, and the Food Fish Management Policy, ORS 506.109, "through the application of consistent goals and standards to mitigate impacts to fish and wildlife habitat caused by land and water development actions" (OAR 635-415-500). The Department of Fish and Wildlife will "require or recommend, depending on habitat mitigation requirements and opportunities provided by specific statutes, mitigation for losses of fish and wildlife habitat resulting from land and water development actions" (OAR 635-415-010). According to Oregon Insider, Issue No. 48, October 14, 1991, the guidelines developed by ODFW will assist staff "in making their mitigation recommendations on permits issued by other state agencies." Further, Oregon Insider reports that "it is not unusual for state agencies to require developers to offset or mitigate the damage their activities have on fish and wildlife habitat."

In 1985 ODFW developed fish and wildlife habitat protection criteria to implement the Wildlife Policy. These are also used by ODFW to evaluate environmental impact statements on federal lands within Oregon, including those lands managed by the federal Bureau of Land Management (BLM). In November 1990, ODFW submitted to BLM a document entitled: "Plan Review Criteria to Conserve Fish and Wildlife Resources on Bureau of Land Management Forest Lands in Western Oregon." The document includes guidelines for "riparian habitats," "aquatic habitats," and "meadows, freshwater wetlands, and natural openings" within forest environments. The forest plan review criteria ODFW outlines for each of the major areas of concern are a combination of best management practices and management directives.

The habitat mitigation policies may be useful in a comprehensive watershed management program for coordinating the land use practices of other agencies with respect to their cumulative impacts on water quality and wildlife habitat. Department of Fish and Wildlife staff may be very helpful in on-the-ground monitoring of watershed areas. Further, ODFW staff already have experience in working with the public on watershed management issues through the Salmon and Trout Enhancement Program, a program designed to involve the public in salmon and trout protection and enhancement efforts.

The Department of Fish and Wildlife also establishes criteria for the designation of lands as riparian lands for the purposes of allowing private landowners tax relief in exchange for limiting the uses to which that land is put. The lands under consideration must be zoned for agriculture or farm uses and not be within an urban growth boundary. Tax relief in exchange for habitat conservation may also be a useful tool in managing watershed areas impacted by private lands.

## 4.6. WATER RESOURCES DEPARTMENT (WRD)

### *4.6.1. Basin Planning*

WRD separates Oregon into 20 different drainage basins, including three for the North, South and Mid Coast regions. In 1987, the Water Resources Department created a Resources Management Division which is to "develop, coordinate and integrate state programs and policies; conduct investigations into the characteristics and uses of ground water and surface water; and conduct contested case hearings." In 1988, the Water Resources Commission approved modification of the basin-by-basin planning system, and adopted "a new state-wide water policy element" (WRD 1987-88). The basin planning process continues with the added element of state-wide water policies, similar to the land use planning Goals.

### *4.6.2. Instream Water Rights*

In 1987, the Oregon legislature passed the Instream Water Rights Act, providing a mechanism for balancing fish and wildlife habitat needs and recreational interests with traditional water uses which have mostly focused on out of stream withdrawals. Oregon's first major water laws were enacted in 1909. These first laws provided a procedure for making determinations and keeping records of the water rights to the surface waters of the state that were initiated prior to February 24, 1909. These were called vested water rights.

The 1987 legislature also created a state instream water right program. SB 140 required the Water Resources Commission to convert existing minimum streamflows to instream water rights. Instream water rights are different from minimum stream flows in that they cannot be waived by WRC during a time of water shortage.

Under ORS 537.332 to 537.360, public uses of water can be protected by the issuance of water rights. Instream water rights are held in trust by the Water Resources Department for the benefit of the people of Oregon. Public uses are broadly defined to include conservation, maintenance and enhancement of fish and wildlife and aquatic life, fish and wildlife habitat and any other ecological values. Public benefit also includes recreation, pollution abatement and navigation. Public benefit means a benefit that accrues to the public at large rather than to a person, a small group of persons or to a private enterprise. The act also established a process for reserving water for future out-of-stream use for economic development. An instream water right does not diminish the public ownership of the waters of the state, nor does an instream water right take away or impair any permitted, certificated, or decreed water use right vested prior to the date of the instream water right.

The act also specifies that the use of state waters for multipurpose storage or municipal uses or by a municipal applicant for a hydroelectric project shall take precedence over an instream water right, except if the instream water right was converted from a minimum stream flow requirement, or resulted from a lease or transfer of an existing water right.

The instream water right laws include an incentive for water right holders to conserve water. (ORS 537.470). However, 25% of the conserved water generally will be allocated to the state for instream or other purposes. The statute also allows a person to purchase or lease an existing water right or portion of a water right or accept a gift of a water right for conversion to an instream water right. Any water right purchased pursuant to the 1987 act will retain the priority date of the water right purchased, leased or received as a gift. Any person may lease an existing water right for use as an instream water right for a specified period without losing the original priority date (ORS 537.340).

Three state agencies can apply for instream water rights. Oregon Department of Fish and Wildlife (ODFW) has the authority to request certificates for instream water rights in which there are public uses relating to the conservation, maintenance and enhancement of fish and wildlife or fish and wildlife habitat. When ODFW applies for instream water rights, of primary importance is the protection of federally and state listed threatened and endangered species. The Department of Environmental Quality (DEQ) may be granted a water right to protect and maintain water quality standards. The Department of Parks and Recreation may request a certificate for instream rights to state waters in which there are public uses relating to recreation and scenic attraction. When applying for instream rights, Parks gives priority to streams designated as a state Scenic Waterway or national Wild and Scenic River (ORS 536.336).

## 4.7. Oregon Scenic Waterways Program

The Oregon Scenic Waterways System was created through an initiative measure enacted by the voters of Oregon in 1970. ORS 390.815 establishes that "the people of Oregon find that many of the free-flowing rivers of Oregon and Waldo Lake and lands adjacent to such lake and rivers possess outstanding scenic, fish, wildlife, geological, botanical, historic, archaeologic, and outdoor recreation values of present and future benefit to the public." The statute further stipulates the policy that the "construction of dams and other impoundment facilities...should be complimented by a policy that would...protect and preserve the natural setting and water quality of the lake and such rivers and fulfill other conservation purposes."

The definition of "scenic waterway" includes Waldo Lake and rivers or river segments which are currently designated as scenic waterways under the statute, "and includes related adjacent land" (ORS 390.805(1)). "Related adjacent land" is defined as "all land within one-fourth of one mile of the bank on the side of Waldo Lake, river or segment of river within a scenic waterway, except land that, in the department's judgment does not affect the view from the waters within a scenic waterway" (ORS 390.895(2)). "Scenic easement" is defined as "the right to control the use of related adjacent land...for the purpose of protecting the scenic view from waters within a scenic waterway; but such control does not affect, without the owner's consent, any regular use exercised prior to the acquisition of the easement, and the landowner retains the right to uses of the land not specifically restricted by the easement" (ORS 390.805 (3)).

While the statute may be effective to control potential uses of adjacent riparian lands, the criterion for controlling uses of the scenic easement is limited to "protecting the scenic view" as opposed to protecting water quality. Furthermore, the statute does not affect land uses initiated prior to designation of the waterbody as a Scenic Waterway which may limit the use of the Scenic Waterways Program in a comprehensive watershed program to protecting riparian areas from future land uses which may adversely affect water quality, but will not be instrumental in remedying current adverse land uses.

The statute also states that "the free-flowing character of these waters shall be maintained in quantities necessary for recreation, fish and wildlife uses" (ORS 390.835). The statute prohibits dams, reservoirs, the construction of impoundment facilities or placer mining activities on waters within scenic waterways (ORS 390.835). Water diversion activities not previously permitted must be approved by WRD as consistent with the Scenic Waterways System policy. Removal-Fill activities are likewise prohibited unless the Division of State Lands (DSL) finds the activity is compatible with the Scenic Waterways designation (ORS 390.835). The Parks department is mandated by statute to develop rules for the management of adjacent lands. Statutory guidelines for these rules include: "(b) [f]orest crops shall be harvested in such manner as to maintain as nearly as reasonably is practicable the natural beauty of the scenic waterway; (c) [o]ccupants of related adjacent land shall avoid pollution of waters within a scenic waterway" (ORS 390.845).

In 1988, the Oregon Supreme Court decision in Diack v. City of Portland, 306 Or. 287, 759 P.2d 1070 (1988), prohibited uses upstream of a scenic waterway that would affect the scenic waterway. The Diack decision primarily affected water quantity issues. Prior to Diack, the Water Resources Commission restricted the application of the scenic waterway act to the designated portion of a waterbody, whereas, after Diack, the Commission "must also consider scenic waterway values when considering proposed appropriations upstream of a scenic waterway" (Murray 1991). At the time of the decision, minimum stream flow requirements to "maintain recreation, fish, and wildlife uses" for only one scenic waterway in the state had been determined. Thus, in 1989 the Commission put a freeze on all applications for water diversions which were in or upstream of a scenic waterway until minimum flows could be determined (Murray 1991).

The impact of Diack on water quality as opposed to water quantity is not as clear (Murray 1991). Non-point sources such as siltation resulting from timber harvesting adjacent to a waterway impacts the quality of the waterway for fish habitat. Erosion as a result of grazing practices has adverse impacts on fish habitat as well. The Oregon Department of Environmental Quality would be responsible for monitoring these non-point source effects on fish habitat (Murray 1991).

Controversies have arisen between river users and adjacent landowners stemming from the establishment of the lower Nestucca River Scenic Waterway which has been designated as a Scenic Waterway from "below the McGuire Dam downstream to its confluence with East Creek (near Blaine); and...Walker creek from its source downstream to its confluence with the Nestucca River" (ORS 390.826 (11)). The Scenic Waterways process is one that does not necessarily involve adjacent land-owners in the decision to designate a waterbody, as would be the case in a citizen initiative which is also authorized by the statute. Conflicts between recreational users and landowners would most likely develop if such a process were used to designate a complete waterbody for protection.

While the primary purpose of the land use controls imposed on adjacent riparian areas is to protect the scenic view from the waterway, the Scenic Waterways System does coordinate land use and water quality to some extent. The language in the statute calling upon adjacent landowners to "avoid pollution of waters" in a Scenic Waterway may not be strong enough to have any significant impact on improving water quality. However, to the extent that the Scenic Waterway Program does add some protection for specific waterways, it may be useful for certain reaches of a waterbody as part of a comprehensive watershed program.

### 4.8. DEPARTMENT OF FORESTRY

The 1991 Legislature in Senate Bill 1125 directed the Board of Forestry to review its water classification and protection rules and, where appropriate, make amendments. In conducting this review, SB1125 established a new and clear target for water quality standard achievement that needed to be considered. This target is that best management practices adopted by the Board are to ensure compliance with state water quality standards to the maximum extent practicable.

Consistent with this direction, in April 1994, the Board of Forestry adopted new water classification and protection rules that will become generally effective September 1, 1994. These new rules achieve significant improvements in riparian habitat protection.

Among the key components of the rules are:

1) A process is provided for the Board to adopt special protection rules for water quality limited (WQL) streams or streams with threatened and endangered aquatic species. This supplements the ability to meet obligations on WQL streams, and provides a prompt response should additional forest species be listed at either the state or federal level. This process can facilitate compatibility with a watershed approach to resource management under these conditions.

2) All fish–bearing streams will be provided a riparian management area that includes vegetation retention as compared to the current standard of vegetation retention being applied only to those streams with "significant" fish use. The rules commit the Department of Forestry (with the help of the Department of Fish and Wildlife) to a comprehensive fish use survey of forest streams. Based on the surveys completed during the summer of 1993, such a comprehensive survey might increase by as much as 30% the miles of forest streams that will receive protection consistent with fish use. Some years will be required to complete a survey of this magnitude, and the rules provide an interim process under which fish use is assumed up to the first barrier to fish migration.

3) The new water classification system, identifying seven geographic regions, distinguishes between streams that have fish or domestic use, or neither; and in each case whether the stream is of large, medium or small size, based on water volume. Significant wetlands, stream–associated wetlands, other wetlands, and lakes are classified by size.

4) A new approach of conifer basal area instead of number of trees is used to establish the required vegetation retention. The volume of conifer that will be retained along fish–bearing streams, especially large fish–bearing streams, is substantially increased over the current standards.

   In addition to the conifer retention requirements, for all fish–bearing, all domestic use and all other medium and large streams, the first 20 feet from the stream will generally not have any tree harvesting allowed unless stand restoration is needed.

5) The proposed rules provide incentives for landowners to purposely place large woody debris in streams to provide immediate enhancement of fish habitat. Other alternatives are provided to address hardwood dominated sites, site–specific conditions and large scale catastrophic events.

6) Proposed rules related to harvest practices, road construction, skid trail location, stream crossings, and fish passage are strengthened considerably. Fish passage will now be required for both juvenile and adult fish, up and downstream, during periods when fish passage would normally occur. Stream crossings will need to be designed for the 50–year storm event, rather than the current 25–year storm event standard.

## 4.9. Oregon Department of Agriculture

In passing SB 1010, the 1993 Legislature provided for the Oregon Department of Agriculture (ODA) to be the lead state agency working with agriculture to address non–point source water pollution. Under the bill the department is authorized to develop and carry out a water quality management plan for any agricultural and rural lands where a water quality management plan is required by state or federal law (for example, TMDL basins, groundwater management areas, coastal zone management area). The plans may require actions on the land necessary for the prevention or control of water pollution resulting from agricultural activities and soil erosion, including but not limited to construction, maintenance and clearance, and agricultural and cropping practices. If people refuse to comply with the requirements of the plan, the department may assess civil penalties for violations. The mechanism for addressing concerns of the Environmental Quality Commission (EQC) and the Department of Environmental Quality (DEQ) are identical to the mechanism in the Forest Practices Act.

Senate Bill 1008 transfers the Confined Animal Feeding Operation (CAFO) program to ODA, allowing ODA to perform any function of the EQC or DEQ relating to confined animal feeding operations. Enforcement authority includes authority to inspect any CAFO and authority to assess civil penalties against violators.

## 4.10. Agency Coordination and Watershed Management

The Governor's Watershed Enhancement Board and the Strategic Water Management Group are two state agencies which serve to coordinate the activities of other natural resource agencies and serve as channels for state funding of watershed or ground water projects.

### *4.10.1. Governor's Watershed Enhancement Board*

The 1987 Legislature created the Governor's Watershed Enhancement Board (GWEB). The Board consists of 10 members. There are five voting members made up of the chairpersons from the Environmental Quality Commission, the State Fish and Wildlife Commission, the State Board of Forestry, the State Soil and Water Conservation Commission, and the Water Resources Commission. The remaining five are nonvoting members and include the director of the Oregon State University Extension Service, the Director of Agriculture, and representatives from three federal agencies: the Bureau of Land Management, the United States Forest Service and the Soil Conservation Service (ORS 541.360).

Prior to the formation of the Governor's Watershed Enhancement Board, representatives from diverse interest groups with a stake in watershed issues had been meeting for a year as the Oregon Watershed Improvement Coalition. The coalition included four members from the Society for Range Management, five from the Oregon Cattlemen's Association, one each from the Oregon Rivers Council, the Oregon Forest Industries Council, the Oregon Small Woodlands Association, the Izaak Walton League, and the Oregon Environmental Council, two from Oregon Trout, and one publicist (Anderson 1991). The council used methods previously established by the Coordinated Resource Management Process (CRMP). The CRMP process began in Oregon in 1949 with the "Soil Conservation Service, Bureau of Land Management, Eagle Valley Conservation District, and five ranchers who grazed their livestock in common on the Dry Gulch grazing allotment in eastern Baker County" (Anderson 1991). The goals of the early CRMP process were to coordinate resource management practices on public and private land, to coordinate grazing and forest practices, and to address wildlife habitat issues. The CRMP process itself involves consensus-based decisionmaking and implementation of resource management practices. The National Environmental Policy Act of 1969, (NEPA), 42 U.S.C. section 4321 et seq., emphasizes coordination among agencies. NEPA was instrumental in broadening the interest from federal, state, and local agencies and organizations and individuals considering the CRMP process (Anderson 1991).

GWEB is directed to conduct a watershed enhancement program which "coordinates the implementation of enhancement projects approved by the board with the activities of the Natural Resources Division staff and other agencies, especially those agencies working together through a system of coordinated resource management planning" (ORS 541.370(1)(a)). The Watershed Enhancement Board is funded by the legislature to oversee and fund local watershed enhancement projects. The Board must encourage the use of nonstructural methods to enhance the riparian areas and associated uplands of Oregon's watersheds (ORS 541.370(1)(j)). The Board is primarily staffed by the Water Resources Department, and receives technical assistance from other state natural resources agency staff. The establishment of GWEB emphasizes the need for greater agency coordination with respect to the projects of individual agencies affecting watersheds. The statute mandates that GWEB maintain a "centralized repository" of natural resource agency documents of projects affecting watersheds.

#### *4.10.2. Strategic Water Management Group (SWMG)*

In 1987, the State Legislature created the Strategic Water Management Group (SWMG) (ORS 536.100). The 14-member group consists of the following members or their designees:

- Governor
- Director of the Department of Environmental Quality
- State Fish and Wildlife Director
- Director of the Department of Energy
- Director of the Division of State Lands
- State Geologist
- Director of the Parks and Recreation Department
- Director of the Executive Department
- Water Resources Director
- Director of Agriculture
- Director of the Department of Land Conservation and Development
- State Forester
- Assistant Director of the Health Division of the Department of Human Resources
- Director of the Economic Development Department

Originally one of the primary functions of SWMG was to monitor hydroelectric power projects pending before the Federal Energy Regulatory Commission. In addition, SWMG would work toward establishing a "comprehensive plan for improving, developing and conserving Oregon's waterways." The elements of the plan include "all state statutes, interstate compacts and constitutional provisions establishing policy for or regulating waterways, water use and fish and wildlife...all state agency rules, policies and plans related to the use or management of waterways in Oregon...all local comprehensive plans...insofar as the plans govern the use or management of waterways in Oregon... and "all appropriate state agency or local government water-related data, inventories of river basin resources and evaluations of the anticipated demands for these resources." The comprehensive plan represents the "state's planning to improve, develop and conserve Oregon's waterways; the needs and uses of all Oregon rivers; and the state's own balancing of the competing uses of Oregon waterways" (ORS 390.835).

SWMG is also responsible for coordinating agencies and processing requests for funding ground water projects. SWMG has statutory authorization for the creation of Groundwater Management Committees which will identify an area of groundwater concern and develop and promote a local action plan for the area of concern (ORS 536.135). The local action plan includes the identification of practices contributing to deterioration of ground water quality and the non-point sources of pollution that are a threat to ground water quality. The local action plan will also evaluate and recommend alternative practices for dealing with non-point sources of pollution and recommend Best Management Practices for preventing these sources of pollution (ORS 536.135).

SWMG, through the Groundwater Management Committees, will then designate a lead agency for development and implementation of the action plan aimed at improving ground water quality. The designated agency then determines whether amendments to city or county comprehensive plans will be needed, and may adopt rules to carry out the plan. Two or more agencies affected are authorized to consolidate rule-making proceedings (ORS 536.165).

### *4.10.3. Integrated Resource Management Approach for Watersheds*

As opposed to the creation of a new agency or council to direct management of water resources, both GWEB and SWMG represent the "enforced" coordination of existing avenues of water management-natural resource agencies, state and local government information sources and data bases and local comprehensive plans. From a standpoint of government efficiency, utilizing the bureaucratic structures already in place and directing them toward a common end may be the most effective way to manage watershed water quality. At the initiation of Governor Barbara Roberts, one of the groups formed under SWMG has become the forum for directors of state natural resource agencies to discuss the feasibility of combining several of the state natural resource agencies into one Department of Land and Water. One of the critical issues in these discussions is whether this coordination will result in added layers of bureaucracy, making public involvement and public access to information more difficult, or whether the merger can effectuate the goals of greater communication and coordination which is an area needing improvement within the existing state agency structure. SWMG and GWEB reflect a trend toward integrated resource management which appears to be the most effective way of coordinating individual agency efforts associated with watershed management.

### *4.10.4. Watershed Management and Enhancement Program*

SWMG, in conjunction with Water Resources Department, has developed an outline for an Oregon Watershed Management and Enhancement Program. The goal statement calls for the implementation of a "consistent and integrated process to guide watershed-based resource planning." Water managers at all levels of government as well as interested citizens will be involved in "development, implementation and monitoring of watershed action programs" (Strategic Water Management Group 1992). The outline establishes criteria for identifying high priority watersheds as well as outlines the process for program development and implementation. The outline contains a list of proposed watershed management tools, including "organizational," "descriptive," "implementation," and "protection" tools, and funding sources. The proposed management tools are the result of "votes" cast by members of the Strategic Water Management Group at the June 16, 1992 meeting. Finally, the outline includes a summary of existing local, state, and federal watershed management tools.

The implementation of the watershed program will be primarily through a partnership between state and local government. For each priority watershed a local "Watershed Council" will be established. Membership on the Watershed Council will include "representatives of (1) local government, (2) non-governmental organizations, and (3) private citizens, including but not limited to: representatives of local and regional boards, commissions and agencies; Indian tribes; public interest group representatives; private landowners; industry representatives; and academic, scientific and professional community." A focus of the Watershed Council is to prepare a Watershed Action Program which will be reviewed and adopted by SWMG. The Watershed Council is responsible for implementing, evaluating and monitoring the program, with the oversight of SWMG. This approach will be tested under 1993 Oregon legislation appropriating $10 million for watershed restoration in northeastern and southwestern Oregon.

In the section on Proposed Watershed Management Tools, priorities were determined by vote of SWMG members for each of five management areas. For organizational tools a majority of the members voted for more involvement of the Governor's Watershed Enhancement Board at the state level, and at the local level, the watershed council idea received the most votes. Descriptive tools identified as high priorities included data management by watershed, coordination of state Geographical Information Service (GIS) databases through a state GIS service center, and the need for long-term watershed monitoring. Some priorities for implementation tools included use of reduction of waste and inefficient practices, water marketing to encourage the reallocation of water, and a focus on riparian management through the creation of voluntary conservation easements, and easing the livestock pond process. For protecting watersheds, enforcement of instream flows and education were identified as having a high priority. Funding options identified included use of incentives, as well as disincentives, and 1991 legislation, HB 3213, "which authorized soil and water conservation districts to charge fees for activities in water quality limited basins."

### 4.11. INTEGRATED MCKENZIE WATERSHED PROGRAM

Lane Council of Governments (L-COG), under contract with Lane County and the Eugene Water and Electric Board, evaluated the potential for an integrated watershed management program for the McKenzie River. The April 1992 Scoping Report took a broad look at the McKenzie watershed to describe the geography and physiography, identify the watershed boundary, suggest possible subbasin boundaries, and start to identify affected interests. Also completed was a review of the existing studies and databases of information currently available on the McKenzie watershed, and identification of the affected local, state and federal agencies which might be involved in a coordinated program (Lane Council Of Governments 1992).

Examples of competing demands on the McKenzie watershed identified in the scoping report are: domestic water supply, hydropower, public access, agriculture, scenic values, wildlife and fisheries habitat, recreation, private property rights, forestry, and sand and gravel. Because of the varied interests affected by and having an effect on the watershed resource, the scoping report determined that the development of an integrated watershed management program is the most effective way to manage the resource while avoiding intensification of competing demands. The existing management efforts are not presently coordinated, and doing so would allow for coordination of natural resources data-bases, as well as coordination of decisionmaking. Public involvement was also identified in the scoping report as being important in the creation of the management program.

The focal issue addressed by this investigation into comprehensive management was "Protecting water quality within the entire watershed while balancing competing demands for use of land and water." The scoping report has identified some of the major issues stemming from this overall concern which would be addressed by a comprehensive management program. With respect to private property rights, issues such as "preventing takings," "public support for an acquisition program but not for a regulatory program," and "managing public access on private lands adjacent to the river," have been identified. Forestry and agriculture issues include "impacts of forest and agricultural practices and road building on water quality," "requiring best management practices," and "effects of irrigation on water quality and quantity." Other issues include recreation, transportation, hydropower, wildlife habitat, and agency coordination and planning. Also noted by the scoping report were "creating new laws, guidelines, policies, etc., when existing ones are not being enforced," "using hazardous materials at individual and commercial/industrial establishments," and "wellhead protection."

The scoping report looks at several case studies which have been divided into two types, "watershed studies" and "watershed programs." Whereas a watershed study is a compilation of information and data that may "guide decisionmaking " about a watershed, a watershed program is "an administrative and planning structure which has been established to facilitate coordination or implementation of a watershed plan or study." Included in the watershed studies reviewed in the report was the West Eugene Wetland Special Area Study, March 1991, and the Upper John Day River Basin Master Water Plan Working Paper, 1990. Watershed programs included the Bull Run Watershed in Portland and the Cedar River Watershed for Seattle, Washington.

The scoping report recommends a study structure which incorporates a policy committee of decisionmakers from lead agencies, a project manager, a technical advisory committee and a citizen advisory committee. Funding is to come primarily from federal sources; identified sources are the USDA Cooperative River Basin Study program and the NPPC "Model Watershed Program."

The McKenzie Watershed Project was recently appropriated $700,000 by a Congressional Subcommittee in the 1993 Veterans Affairs, Housing and Urban Development and Independent Agencies budget. Some of the money has been used to compile a computer database with information from federal, state and local agencies which have jurisdiction over some aspect of the McKenzie watershed.

## 4.12. PROPOSED OREGON GRAZING PRACTICES ACT/WATERSHED INITIATIVE

Senator Dick Springer, Chair of the Senate Agriculture and Natural Resources Committee created a Senate Sub-Committee on Grazing to discuss the possibilities for the enactment of a Grazing Practices Act or Watershed Initiative Legislation in Oregon during the 1993 Legislative Session. Such legislation was not enacted, but discussions continue in anticipation of the 1995 legislative session.

## 4.13. WATERSHED MANAGEMENT IN OTHER STATES

Other examples of state approaches to the problem of non-point source pollution come from North Carolina's basinwide approach to water quality planning, Washington's legislation managing non-point source pollution for improved shellfish quality, Washington's Timber/Fish/Wildlife Agreement, and Idaho's Agricultural Pollution Abatement Program.

### *4.13.1. North Carolina Basinwide Approach to Water Quality Management*

In order to fulfill the requirements of the Clean Water Act, including sections 201 (c), 208, 303(d), 303(e), and 319, North Carolina has initiated a basinwide approach to water quality management. For each of 17 water basins in the state, the North Carolina Division of Environmental Management (NCDEM) will adopt a basinwide management plan. The plan includes a general basin description, current status of water quality and biological communities, and an assessment of existing pollutant sources and loads. The plan also includes identification of major water quality concerns and priority issues, long-term management goals and strategies, recommended Total Maximum Daily Loads (TMDLs) and management actions, and plans for implementation, enforcement and monitoring (Creager and Baker 1991).

As the basis for future management decisions, the long-term management strategy will "define the rationale, decision analysis framework, methods, and criteria to be used for all decisions regarding the allocation of assimilative capacity among point and non-point sources." "Assimilative capacity" is the total amount of point source and non-point source pollutants a waterbody can assimilate without exceeding established water quality standards (Creager and Baker 1991). The long-range planning incorporates techniques such as "agency banking" of assimilative capacity and pollution trading among dischargers. Also utilized is a process called "industrial recruitment mapping," which is a type of land use planning recommendation for the basin, linking industrial land uses with the basin's assimilative capacity for specific types of discharges. NCDEM also indicates that local landowners and local agencies will be consulted in order to increase the plan's success (Creager and Baker 1991).

The long term goal of each basin plan "is to promote the optimal distribution of assimilative capacity...that (1) achieves the highest possible level of water quality for the lowest possible cost and with the minimum possible disruption of long-term economic growth and development, (2) maintains water quality at or above that required to achieve long-term water quality goals and objectives... and (3) represents, to the degree possible, a fair and equitable distribution of assimilative capacity among potential users." The use of techniques such as agency banking and recruitment mapping will facilitate this goal (Creager and Baker 1991).

Implementation of the basin plans may take several years. The process begins with the compiling of information, identifying priority issues, collecting biological and physical data on the basin, and selecting management options for the basin, with the last phase of implementation being the issuing of National Pollution Discharge Elimination System (NPDES) permits. The basin planning process is an ongoing one, with the length of time varying with the types of point and non-point sources affecting a basin, and the amount of coordination needed among state agencies. NCDEM will develop guidelines for the basin plans to facilitate comparison between basins and establish uniformity for the data, table, and figure formats used in each plan.

A major focus of the basinwide planning process is the coordination of data among agencies and the utilization of Geographic Information Systems. North Carolina's Center for Geographic Information Analysis is a key component of the data management aspect of the program. A 1991 report estimated that approximately $390,000 would be needed to implement centralized data management. In addition to administrative needs, including additional staff people, the Final Report notes that technical improvements are also needed, such as better water quality models, improved estimates of pollutant loads from stormwater runoff, and additional information on the "relationship between land use/landscape ecology and water quality" (Creager and Baker 1991).

### *4.13.2. Washington Shellfish Protection Initiative*

A new law designed to protect Washington's shellfish growing areas from non-point source pollution was signed by Governor Booth Gardner in early April 1992. The bill authorizes the legislative authority of counties to create shellfish protection districts where NPS pollution threatens shellfish harvesting. The shellfish program established by the county to deal with NPS pollution will include "requiring the elimination or decrease of contaminants in stormwater runoff, establishing monitoring, inspection and repair elements to ensure that on-site sewage systems are adequately maintained and working properly, assuring that animal grazing and manure management practices are consistent with best management practices, and establishing educational and public involvement programs to inform citizens of the causes of the threatening non-point source pollution and what they can do to decrease the amount of such pollution" (Engrossed Substitute House Bill 2363, Sec. 2 (1992)). The county may create a shellfish protection district or may submit the proposal for voter approval. In the event that the Department of Health has closed or downgraded the classification of a shellfish growing area within a county, the county must establish a protection plan within 180 days of the downgrade or closure. The act also directs counties to work with conservation districts "to draft plans with landowners to control pollution effects of animal waste" (Engrossed Substitute House Bill 2363, Sec. 5 (1992)). Funding for the shellfish protection programs can come from county tax revenues, reasonable inspection fees or service charges, or from federal, state or private grants.

The act also amended Washington's land use program under the Growth Management Act. Comprehensive land use plans "shall provide for the protection of the quality and quantity of groundwater used for public water supplies and the quality of the marine water in shellfish growing areas" (Engrossed Substitute House Bill 2363, Sec. 11 (1) (1992)).

### *4.13.3. Washington Timber/Fish/Wildlife Agreement*

The Washington Timber/Fish/Wildlife Agreement (TFW) is an agreement reached by consensus between representatives of persons affected by forest practices that result in impacts on fisheries, wildlife and water quality. Participants agreed that forest management should be conducted in such a way as to maintain and protect fisheries, wildlife, water quality and quantity, cultural resources and timber resources. As a result of the TFW agreement and recommendations made by participants, changes may arise in statutes, regulations, and forest management techniques. The TFW agreement works with the Department of Natural Resources (DNR), which regulates forest practices. A new management system to incorporate suggestions of the TFW agreement and improve coordination includes changing the structure of DNR, creating interdisciplinary teams to respond to technical forest practices, and improving public participation and access to agency decision making (TFW Agreement 1987).

The TFW agreement includes addressing cumulative impacts. Forest practices will reflect the need to monitor cumulative effects in watersheds through Resource Management Plans to identify and resolve "problems in those basins to deal with cumulative effects, or baseline regulations which anticipate cumulative effects" (TFW Agreement 1987).

### *4.13.4. Idaho Agricultural Pollution Abatement Program*

Local soil conservation districts in Idaho administer the Idaho Agricultural Pollution Abatement Program to address agricultural NPS pollution in identified watersheds. The soil conservation districts enter into voluntary agreements with private landowners who agree to comply with BMPs to abate NPS pollution. The state provides funding for local watershed programs through inheritance, tobacco, and sales taxes.

The Pollution Abatement Program is centered on a feedback loop concept, contained in the Idaho groundwater plan. Water quality resources are identified, a corresponding BMP is applied to address the protection of the resource, followed by evaluation and modification of the BMP if necessary to reach the desired benefit (Harkness 1992).

## 4.14. CONCLUSION

Existing programs in Oregon including the Forest Practices Act, the statewide land use goals, the NPS pollution program, and the work of the soil and water conservation districts, are conducive to statewide watershed management. Integration of existing programs and coordination among state agencies and between state and local government and private landowners will be challenges for a statewide management program such as that being developed by SWMG.

Washington's TFW agreement is an example of how conflicting uses within watersheds may be resolved through participation of affected user groups in the policy-making process itself.

# 5. A NEW COASTAL NON-POINT POLLUTION CONTROL PROGRAM

## 5.1. INTRODUCTION

The 1990 amendments to the federal Coastal Zone Management Act (CZMA) created a Coastal Non-point Pollution Control program which could prove very significant in maintaining and improving the water quality of coastal watersheds. For estuarine waters, current best estimates show that of the approximately 75% of waters assessed, 10% are threatened and 35% are impaired (Memorandum in U.S. EPA 1991b). The leading sources of NPS pollution in estuarine waters are urban runoff and agriculture. Some of the coastal NPS provisions are viewed by agency and congressional staff as a model for improved responses to NPS pollution to be included in the reauthorization of the Clean Water Act.

The 1990 amendments require coastal states to develop programs to protect their coastal watersheds from non-point source pollution. Modest grant funds are provided to support the coastal state efforts, and fiscal sanctions apply to states that do not comply. States that fail to submit approvable plans by 1996 will have portions of CZMA and Clean Water Act grant funds withheld. Coastal NPS programs must be coordinated with the states' CWA NPS pollution programs and water quality standards.

## 5.2. LEGALIZATION OF NPS POLLUTION CONTROL

New CZMA statutory provisions reflect Congress' increased concern about coastal watershed water quality. CZMA section 302 finds that "Land uses in the coastal zone, and the uses of adjacent lands which drain into the coastal zone, may significantly affect the quality of coastal waters and habitats, and efforts to control coastal water pollution from land use activities must be improved." Under section 303(2)(B) state coastal programs are to provide for "the management of coastal development to improve, safeguard, and restore the quality of coastal waters, and to protect natural resources and existing uses of those waters." Section 306(d)(16) specifically requires state coastal programs to contain "enforceable policies and mechanisms to implement" the states" coastal NPS program. This requirement distinguishes coastal NPS programs from existing NPS efforts such as the Soil Conservation Service's agricultural programs and Clean Water Act (CWA) section 319. However, coastal NPS management measures including land use controls will not be enforceable as a matter of federal law; instead, in the tradition of other components of state coastal programs, they will be developed, implemented, and enforced by the states as a matter of state law.

Under section 6217(e) of the 1990 CZMA reauthorization act, codified at 16 U.S.C. § 1455b, state coastal zone boundaries will be evaluated as to whether they extend inland "to the extent necessary to control the land and water uses that have a significant impact on coastal waters of the state." Coastal state definitions of their CZMA coastal zones vary greatly. The mandated boundary evaluations could be crucial in insuring that the states use ecologically rational boundaries to manage coastal NPS pollution. However, defining the coastal zone's inland boundary was a very sensitive issue in the initial development of many state coastal programs, so some reluctance to modify them on the part of the states can be expected (Powell and Hershman 1991).

Section 6217 also requires the states to identify land uses which individually or cumulatively may degrade coastal waters and critical areas in which new or expanded land uses require special additional management measures. Section 6217(a)(2) makes it clear that state coastal NPS programs, once they are developed "shall serve as an update and expansion" of the state's CWA section 319 NPS program for the coastal waters they cover.

## 5.3. EPA AND NOAA GUIDANCE TO THE STATES

As required by section 6217, the federal Environmental Protection Agency (EPA) has published Coastal Non-point Source Pollution Management Measures Guidance for use by the states in developing their coastal NPS programs. Section 6217(g)(5) defines management measures as "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of non-point sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available non-point pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives."

The EPA and the National Oceanic and Atmospheric Administration (NOAA) have jointly issued Coastal Non-point Source Pollution State Program Guidance. According to CZMA section 306(b)(2) state coastal NPS programs must be submitted to NOAA and EPA for approval within thirty months after EPA issues the final management measures guidance in January, 1993. EPA's guidance specifies management measures to control NPS from agriculture, silviculture, urban development (including construction, septic tanks, highways, bridges, and airports), hydromodification (including dams, levees, impoundments, and shoreline erosion), and marinas as the technical basis for state coastal NPS programs. Measures are included which address wetland and riparian area protection and the use of vegetated filter strips in conjunction with a variety of land uses. The guidance does not impose numerical limits on NPS pollution or address the overall question of coastal economic growth and development.

Under EPA's coastal NPS guidance, the states will employ both technology-based and water quality-based approaches to NPS management. The EPA's goal is to have the states get the management measures on the ground in a short period of time to reduce NPS pollution while implementing additional measures to address known water quality problems. In turn, improved management of NPS pollution sources would be a major, if not the single most important, step toward the overall goal of an integrated watershed approach to water quality problems.

The EPA Region 10 staff in Seattle have strongly urged EPA and NOAA headquarters staffs in Washington, D.C. to allow the region's coastal states to take a watershed protection approach (EPA 1992) in implementing section 6217. This would allow the states to prioritize their efforts on a watershed-by-watershed basis, and thus provide them with flexibility and efficiency in allocating the relatively small resources available for NPS pollution control. According to Region 10 staff, "The reason for controlling non-point sources is to meet the

Clean Water Act goal of protecting the physical, chemical, and biological integrity of the Nation's waters. This requires consideration of overall habitat issues, which is best done on a watershed basis" (Gakstatter 1991) (emphasis added).

## 5.4. Oregon's Coastal NPS Response

With some conceptual and fiscal reservations, Oregon coastal program and water quality staff have responded to the federal coastal NPS program. DLCD director Dick Benner has stated that managing on a watershed basis is what section 6217 is all about. However, the abilities of both DLCD and DEQ, as the state's water quality agency, to respond to section 6217 could be hampered by Measure 5 staffing cutbacks.

DLCD comments on EPA's proposed management measures guidance expressed concern about the feasibility in Oregon of implementing section 6217(b)'s core requirements at the anticipated federal funding levels. Section 6217(b)'s core requirement is that the states implement NPS management measures complying with EPA's final guidance for all their coastal waters regardless of any linkage to identified coastal water quality problems because of the enormous difficulty of establishing cause and effect linkages between land use and water quality. Subsection (b) also requires a second tier of state coastal NPS pollution control efforts that focus on coastal land uses that are recognized contributors to coastal water quality problems. DLCD expects that second tier measures which are specifically applied to identified water quality problems will work better than the core requirements under which communities and individuals are expected to change their activities without a clear idea of the reason for doing so. To make the core requirements work, an extensive information and education program will be necessary prior to implementation. DLCD also expressed concern about NOAA's methodology for reviewing state coastal program boundaries.

With these perspectives in mind, DLCD applied for federal coastal program enhancement funds in spring 1992 under CZMA section 309 to carry out a watershed-based water quality protection program. While the program was not funded under section 309, it could be implemented when coastal NPS funds become available. The water quality sections of existing coastal county plans will be the starting point. The program will verify the existence of coastal NPS problems and revise local comprehensive plans to control NPS pollution in coastal watersheds based on a state agency adopted coastal watershed protection policy. A Coastal Watershed Assessment will be prepared for each drainage basin starting from DEQ's 1988 Non-point Source Assessment. To move beyond water quality data to assess watershed quality, coastal land uses will be digitally mapped and basins and sub-basins that need increased watershed protection will be identified. Model local ordinances and a Coastal Watershed Protection Manual also will be developed. The clear intent is to move beyond past water quality control efforts to true total watershed management.

## 5.5. Tillamook Bay's Contribution to the National Estuary Program

Nationally the section 6217 coastal NPS program is viewed as assisting the National Estuary Programs (NEP) designated by EPA under CWA section 320 in coping with NPS problems. Such coordination is mandated by section 6217(a)(2). Management plans for NEP estuaries such as Puget Sound, Casco Bay in Maine, Buzzard Bay in Massachusetts, and

Chesapeake Bay identify and propose remedies for NPS pollution. However, the plans, even when approved by EPA, remain advisory only. Thus the section 6217 program can assist state and local governments involved with NEP estuaries with implementation and enforcement of NPS pollution controls.

Tillamook Bay on the northern Oregon coast recently was designated under the NEP program. EPA designation brought $150,000 in federal funds the first year, and will bring a maximum of $2.5 million over 4 years. Tillamook Bay water quality suffers from excessive sedimentation and bacterial contamination that has forced periodic commercial shellfish harvest closures. A well-designed and executed NPS management plan for Tillamook Bay could serve as a model watershed based approach for both the NEP and section 6217 programs.

### 5.6. FEDERAL AND STATE AGENCY OBLIGATIONS TO COMPLY WITH OREGON'S COASTAL NPS PROGRAM

The 1990 CZMA amendments support coordinated state agency approaches to watershed water quality in several important ways. CZMA section 306(d)(15) was added to require that by November 5, 1993 state coastal programs include "a mechanism to ensure that all State agencies will adhere to the program," including the program's enforceable policies regarding coastal NPS pollution developed under section 6217. Section 6217(b)(6) itself requires that the state's coastal NPS program include "mechanisms to improve coordination among State agencies and between State and local officials responsible for land use programs and permitting, water quality permitting and enforcement, habitat protection, and public health and safety" including mechanisms such as joint project review and memoranda of agreement.

In Oregon, state agency consistency with the state's coastal program and statewide land use planning Goal 6's mandate to avoid degrading the state's river basins is already required by provisions of the state land use planning law. With improved implementation and enforcement, those provisions could provide the legal foundation for Oregon's compliance with section 306(d)(15) and section 6217(b)(6).

In addition, the CZMA's federal consistency provisions as strengthened by the 1990 amendments can be used by state coastal program agencies such as Oregon's DLCD to review federal actions anywhere in state watersheds including both water and upland areas for coastal zone water quality impacts. The federal actions covered include federally funded and permitted activities of non-federal actors as well as federal construction and public lands management activities. Under CZMA section 307 as amended in 1990, any such federal action whether inside or outside the coastal zone "affecting any land or water use or natural resource of the coastal zone" must be consistent with the enforceable policies of the state's coastal program with only limited exceptions. Thus states which develop strong coastal NPS policies pursuant to section 6217 are provided with both procedural and substantive bases for subjecting federal actions affecting the coastal zone to those and other relevant policies of the state's coastal program.

Congress also is requiring specific federal programs to be carried out consistently with state coastal NPS programs as well as state CWA section 319 NPS management programs. For example, for federally aided highway construction under the Intermodal Surface

Transportation Efficiency Act of 1991, section 1057 deals with erosion control during highway construction in the following way:

> (a) DEVELOPMENT. The Secretary [of Transportation] shall develop erosion controls guidelines for States to follow in carrying out construction projects funded in whole or in part under this title.
>
> (b) MORE STRINGENT STATE REQUIREMENTS. Guidelines developed under subsection (a) shall not preempt any requirement made by or under State law if such requirement is more stringent than the guidelines.
>
> (c) CONSISTENCY WITH OTHER PROGRAMS. Guidelines developed under subsection (a) shall be consistent with both non-point source management programs under section 319...and...guidance under section 6217(g)...

CWA reauthorization legislation could require EPA to be consistent with its own actions and the actions of the Secretaries of Commerce and Transportation under the coastal NPS and highway legislation respectively. These legal linkages to coastal and section 319 NPS controls, if consistently inserted by Congress into federal program legislation, could strengthen NPS management significantly. The inclusion of such provisions in federal legislation governing the management of national forests and other federal public lands discussed below would support application of state coastal NPS program requirements under the CZMA consistency requirements discussed above to federal public lands and apply state section 319 NPS management to federal public lands as well.

### 5.7. A Policy Question for Further Evaluation: The Relative Contributions of Coastal and Inland Sources to Coastal Pollution

Given the limited federal and state resources available to manage coastal water quality on a watershed basis, it becomes quite important to determine the relative contributions of upriver versus coastal pollution sources to coastal water quality problems. A recent journal article (Phillips 1991) reached the following conclusions based on research in North Carolina:

> A watershed-based approach to water quality management is necessary for protecting coastal water quality, but the relative importance of inland pollution sources on estuaries is often overestimated....The over-estimation of upstream contributions is attributable to a failure to recognize that many estuaries have little or no inland drainage area, the confusion of basinwide pollutant loading with pollutant delivery to estuaries, the low delivery ratios for many pollutants within drainage basins, and disproportionately high pollutant delivery for sources within the coastal zone....As a general rule, resources expended on pollution control within or near the coastal zone will result in more coastal water quality improvement per unit effort than resources expended upstream....
>
> This is not to say that the watersheds that feed estuaries should be ignored by coastal water resource managers....More important, water quality in inland sections of a basin should be of equal concern to that of coastal waters. But

there is no denying that where estuarine water quality is the sole concern, the greater pollution control per unit effort is achieved by giving priority attention to sources in and near the estuary.

If these views reflect scientific consensus and they are equally applicable to Pacific Northwest estuaries, they have important implications for coastal water quality management in general and for the design and implementation of state coastal NPS programs in particular.

# 6. WATER LAW PRINCIPLES RELEVANT TO A WATERSHED APPROACH AND CUMULATIVE IMPACT ANALYSIS

## 6.1. INTRODUCTION

While pollution control law focuses on water quality, state water law governs the allocation of water quantities from rivers and lakes for both instream and out of stream uses such as irrigation. In addition, the states own the beds of navigable rivers and lakes (subject to the public trust doctrine discussed below), while the adjacent landowners share ownership of the beds of non-navigable water bodies.

Obviously, diversion of significant quantities upstream will affect water quality downstream, yet traditional western state water law tends to ignore those quality effects so long as the upstream diversion is otherwise for a beneficial use. This includes diversions completely out of the basin which eliminate any possibility of significant return flow to the river after the beneficial use. Even where there are significant return flows, quality problems may be increased because the return flow is of lesser quality due to salts, fertilizers, pesticides, sediments, etc., than the water diverted. Furthermore, critical characteristics such as temperature and chemical composition are affected when water is diverted or held in a reservoir. Each diversion can increase the concentration of natural or human-caused contaminants in the water that remains. Pumping water from a well can draw pollutants into previously uncontaminated ground water aquifers which themselves contribute to surface stream flows. Individual water uses may not seriously affect the quality of water in a stream or aquifer, but the cumulative effects may be quite serious.

Two reasons such water uses have not been controlled in order to protect water quality are the number of small, individual uses that are involved and a tradition of respecting long-used state water quantity allocations as property-like rights in designing much more modern federal and state pollution control laws. Even with increased emphasis on NPS pollutants, those laws still tend to focus regulation on point source discharges by industrial waste and municipal sewage dischargers rather than diversions which adversely affect water quality. In addition, irrigation return flows are specifically excluded from point source control under the CWA, leaving pollution from agriculture, the largest water user in the West, mostly uncontrolled. (National Research Council 1989).

Fortunately, water law is evolving toward greater recognition of the linkages between quantity allocations and water quality. Within state water law, one finds increasing state legislative and judicial recognition of quantity allocations to instream purposes such as fish, wildlife, habitat, and recreation. (Western Governors' Association 1986). One also finds proposed diversions being rejected or modified based on federal and state pollution control, wetlands, and species protection legislation. This section of the report reviews those trends for developments of special significance to watershed approaches to water quality and cumulative impact analysis.

In a previous Congress one bill to reauthorize the CWA would have shifted EPA's focus from pollution control to stream quality management. As Senator Mark Hatfield recognized, such a shift would have significant implications for traditional state control over water allocations. In response, he introduced a bill which would have established a fourteen-member Western Water Policy Review Commission to undertake a comprehensive review of western water resource problems and programs. The Commission would have reviewed the respective roles of the states and the federal government and decided whether additional federal water storage projects were needed. A comprehensive review of all water laws would have been performed as well. According to Senator Hatfield:

> We must continuously work toward a doctrine of conservation and wise use of our finite water resources. Coordination and interrelation of competing water uses and needs such as agriculture, urban consumption, industry, recreation, and fish and wildlife is the primary goal of the [proposed] Western Water Policy Review Act (Hatfield 1992).

Pending such a comprehensive review, western state water law continues to evolve incrementally in directions supportive of watershed approaches sensitive to cumulative impacts on water quality. Under principles of prior appropriation, those who diverted a river's flow first for a beneficial use such as irrigation or municipal water supply are protected in low flow years against other competing uses of the flow, including instream needs. However, in England and eastern states of the U.S., the courts apply the very different principles of riparianism which classically confined rights to use water to landowners adjacent to the river for uses within the watershed. California applies riparianism together with its prior appropriation system. For example, Deetz v. Carter, 43 Cal. Rptr. 321 (1965), protected the domestic water uses of downstream riparians against an upstream riparian's agricultural diversion.

As water law professor Dan Tarlock has commented:

> From the beginning, western courts rejected the watershed limitation, but many recent...[decisions] modify the law of prior appropriation and reintroduce the...watershed protection rule in the form of a premise that river systems should be managed on an ecosystem basis....These [decisions]...reflect the transition of the West from an irrigation economy to a series of urban and environmental oases. They also reflect the decay of the progressive era understanding that water conservation equals...storage and the emergence of an environmental ethic for water management. (Tarlock 1991a).

## 6.2. Opportunities for Incremental Water Law Reform

Illustrative of this trend is a recent Nevada Supreme Court decision. Most state water allocation statutes, including Oregon's, authorize the diversion permit granting authority to weigh the public interest in deciding whether to grant a permit. In State v. Morros, 766 P.2d 263 (Nev. 1988), the Nevada Supreme Court determined that watershed protection through maintenance of lake water levels sought by federal agencies for recreation and fishery purposes was consistent with the public interest. With such precedents as part of state water law, watershed protection becomes a legitimate basis for administrative denial or conditioning of permits to avoid adverse watershed impacts.

Also illustrative are recent California court decisions interpreting California water law in ways much more sensitive to watershed values, instream uses, and cumulative impacts on water quality than has been traditional in the West. While these decisions are indicative of the ways water law could evolve in other western states such as Idaho, Oregon, and Washington, no other western state's courts have gone so far as California in those directions. In fact, a 1993 Washington Supreme Court decision refused to apply the public trust doctrine to a dispute between competing private water users on a river. Rettkowski v. Department of Ecology, 122 Wn. 2d 219 (1993).

Applying the public trust doctrine to prior appropriation water law, California courts are reviewing long-established and proposed new diversions for their impacts on watershed flora, fauna, habitat, water quality, and even air quality. In National Audubon Society v. Superior Court, 33 Cal. 3d 419, 658 P.2d 709, 189 Cal. Rptr. 346 (1983), cert. denied, 464 U.S. 977 (1983), the California Supreme Court found that the Los Angeles Department of Water and Power's decades of previously approved diversions of water from the feeder stream of Mono Lake were open to reexamination to insure protection of such public trust values.

Nearly a decade later, the operational meaning of this decision is still under both judicial and regulatory review, but interim protection for stream flows into Mono Lake was provided by other litigation under California's Fish and Game Code sections 5937 and 5946 requiring Los Angeles to release sufficient water to protect fisheries in the feeder streams. California Trout, Inc. v. State Water Resources Control Bd., 207 Cal. App. 3d 585, 255 Cal. Rptr. 184 (1989); California Trout, Inc. v. Superior Court, 218 Cal. App. 3d 187, 266 Cal. Rptr. 788 (1990).

In April 1991 in the public trust action Superior Court Judge Terrance Phinney ruled that the lake level must be stabilized at 6,377 feet and that Los Angeles cannot divert any water from the four feeder streams until the lake, at 6,375 and falling in the drought summer of 1991, rose two feet. In the Matter of Mono Lake Water Rights Cases, Nos. 2284 and 2268, Superior Court of El Dorado County, April 17, 1991. Thus Los Angeles lost about 50,000 acre feet of its water supply, but the state legislature appropriated $60 million for replacement supplies. It will most likely be spent on water conservation projects, the conjunctive use of groundwater, and water rights purchases in the southern San Joaquin Valley.

In United States v. State Water Resources Control Bd., 182 Cal. App. 3d 82, 227 Cal. Rptr. 161 (1986), the California intermediate court of appeal applied the public trust doctrine and California constitutional and statutory provisions regarding public water uses in ruling that state water quality standards requiring minimum flows to protect the ecological functions of the Sacramento-San Joaquin delta could be established even though they might interfere with the previously established water entitlements of private, federal, and state projects. To date the court's suggestion for basin wide management has not been implemented by the state water resources board. The board's first report suggested that water saved through user conservation measures be used to maintain the required salinity balance but major water users forced the board to reexamine its conclusions. In May 1991 the board issued a water quality plan to establish salinity, temperature, and dissolved oxygen water quality standards under CWA section 303(c)(2)(A). But in September 1991 the Region IX federal EPA administrator found that the plan was inadequate and refused to approve the salinity and temperature water quality standards (Western States Water, No. 904, Sept. 13, 1991). The delta's future remains a key issue in California water law and politics and, according to Professor Tarlock, "no allocation or reallocation decision that affects water quality there can pass muster until these concerns are addressed." (Tarlock 1991b).

Efforts to protect water quality in California's Sacramento-San Joaquin Delta also involve complex issues of federal and state authority over water resources. In 1978 the California Water Resources Control Board had ordered the federal Bureau of Reclamation's Central Valley Project to reduce its diversions in order to protect the delta's water quality. Water districts that had contracted for project water argued that the board's order was an unconstitutional impairment of the district's contracts with the Bureau because it would result in a cutback in water deliveries. But the California intermediate court of appeal rejected that challenge as part of its decision cited above. See also Madera Irrigation District v. U.S., 985 F.2d 1397 (9th Cir.), cert. denied, 114 S. Ct. 59 (1993).

The board's order as it affected the Bureau was supported by the 1978 decision of the U.S. Supreme Court in California v. United States, 438 U.S. 645 (1978). There the Bureau had applied to the board to impound 2.4 million acre-feet of water from California's Stanislaus River as part of the Central Valley Project's New Melones Dam. Environmental concerns centered on the dam's inundation of a nine-mile pristine stretch of white water that was the most rafted in the west. The California board imposed various conditions on the Bureau's operation of the project including conditions prohibiting full impoundment until the Bureau was able to show firm commitments or at least a specific plan for the use of the water, prohibiting collection of water during periods of the year when unappropriated water is unavailable, requiring that a preference be given to water users in the water basin in which the dam was located, and requiring storage releases to be made so as to maintain maximum and minimum chemical concentrations in the San Joaquin River and protect fish and wildlife. The U.S. Supreme Court rejected the Bureau's challenge to the constitutional and statutory validity of the board's conditions. Under the current wording of the federal Reclamation Act, state conditions imposed on Bureau projects are valid unless they directly conflict with provisions of the federal legislation authorizing the particular Bureau project involved.

More recently, a California trial court applied the California Supreme Court's Mono Lake public trust doctrine decision discussed above to the East Bay Municipal Utility District's request to make a new diversion of water for municipal water supply at Folsom Dam on the American River 23 miles upstream from where it joins the Sacramento River. Environmental Defense Fund v. East Bay Municipal Utility Dist. (No. 425955, Superior Court, Alameda County, Cal., Jan. 2, 1990). The decision was the culmination of nearly two decades of litigation. See Environmental Defense Fund, Inc. v. East Bay Municipal Utility Dist., 52 Cal. App. 3d 828, 125 Cal. Rptr. 601 (1975), aff'd, 20 Cal. 3d 327, 142 Cal. Rptr. 904, 572 P.2d 1128 (1977), rev'd, 439 U.S. 811 (1978), decision on remand, 26 Cal. 3d 183, 161 Cal. Rptr. 466, 605 P.2d 1 (1980).

In his 1990 trial court decision, Judge Richard Hodge relied on the public trust doctrine and California Constitution Article X, section 2 which limits diversions of California waters to beneficial uses. He imposed a physical solution that permitted the diversion but imposed strict downstream flow maintenance requirements primarily to protect Chinook salmon on the ground that the species is particularly affected by the vicissitudes of water flow, temperature and composition, and that there was sufficient data to permit an informed decision regarding the flow regimen required for its protection. He allowed the diversion based on his determination that municipal water quality was a significant consideration and that the upstream point of diversion was "appreciably superior" from the water quality perspective. Included in his decision (which has not been appealed) was the appointment of a special master to monitor compliance with the physical solution's requirements, to develop further reliable data as to those flows required to protect public trust values, and develop a workable flow regimen for drought years (Somach 1990).

These California decisions illustrate the potential watershed water quality benefits, still mostly unrealized at this time, that can be achieved through judicial, legislative, and regulatory reform of traditional western state water law. However, despite the generally incremental nature of those processes, the time required for changes resulting in watershed water quality benefits may be no longer than the time for such changes to occur under most of the legal and policy paths discussed in this report. More immediate and radical changes with potential watershed benefits may come from the application of species protection legislation, mainly the federal Endangered Species Act, to private, local, state, and federal water diversion projects as discussed next.

## 6.3. ENDANGERED SPECIES ACT APPLICATIONS RELEVANT TO WATERSHED WATER QUALITY

For particular watersheds and river basins, ranging in size and significance from the Columbia-Snake to the Klamath and smaller, pending applications of the Endangered Species Act have had and will have significant impacts on basin management. Many of those applications could improve watershed water quality significantly. As the Spotted Owl illustrates, once a species is designated as endangered or threatened by the Secretary of the Interior, then management of the species and its designated critical habitat (such as a watershed or river basin) becomes heavily oriented towards the survival of the species. The act specifically requires federal agencies to avoid jeopardizing designated species and habitat and prohibits anyone from "taking" a designated species, with "taking" very broadly defined to include adverse habitat impacts such as diverting water from a stream designated as critical habitat.

Approximately 150 salmon runs with major problems have been identified in Oregon, Washington, and California (Nehlson, et al. 1991). For ESA designated species, such as three Snake River salmon species and the Klamath Lake sucker fish, designation means habitat protection, and water flow management actions are implemented which can benefit water quality significantly. For example, survival and recovery of the three designated Snake River salmon species depends in part on implementation of significant amendments to the Northwest Power Planning Council's Columbia Basin Fish and Wildlife Program. The amendments include water releases from federal and other dams in the Columbia-Snake Basin timed to aid fish survival and habitat preservation and restoration measures throughout the basin to counter the adverse cumulative impacts of basin development on fish survival and water quality.

The United States Supreme Court and the lower federal courts have consistently interpreted the act as favoring species survival over all other considerations. Suits have been filed questioning whether the significant actions taken in managing the Columbia-Snake Basin and Klamath Lake for species survival go far enough in meeting the Act's stringent mandates. Judicial decisions and administrative actions involving river basins outside the Pacific Northwest illustrate the Act's support for immediate drastic actions with water quality benefits.

In TVA v. Hill, 437 U.S. 153 (1978), the U.S. Supreme Court applied the Act to stop further construction on a nearly completed dam that would have flooded the only then known habitat of the endangered Snail Darter fish. According to Carson-Truckee Water Conservancy Dist. v. Clark, 741 F.2d 257 (9th Cir. 1984), cert. denied, 470 U.S. 1083, the Secretary of the Interior in administering a federal reservoir may devote all water not otherwise contracted for to endangered species protection, and need not sell the water to irrigators or other users. Congress ratified that court decision in the Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990, P.L. 101-618, 104 Stat. 3289 (Tarlock 1991). See also Pyramid Lake Paiute Tribe of Indians v. U.S. Dept. of the Navy, 898 F.2d 1410 (9th Cir. 1990) (Navy's water conservation practices held consistent with its Endangered Species Act obligations).

Riverside Irrigation District v. Andrews, 758 F.2d 508 (10th Cir. 1985), upheld the Corps of Engineers denial of a nationwide permit requested by an irrigation district to construct Wildcat Dam and Reservoir on Wildcat Creek, a tributary of the South Platte River, because the increased use of water which the reservoir would facilitate would deplete the stream's flow and thereby injure a critical habitat of the endangered Whooping Crane.

California's continuing drought conditions have swung operation of the mammoth federal Central Valley Project increasingly toward water releases and other measures for salmon survival. In 1990, the National Marine Fisheries Service listed the Sacramento River winter-run Chinook salmon as threatened (55 Federal Register 46515, Nov. 5, 1990). The United States then sued the Glenn-Colusa Irrigation District, the largest capacity water diverter on the river, to enjoin the district's water diversions until it adopted interim measures such as intake screens to protect the salmon. The federal district court ordered the district to reduce its pumping rate by nearly 50%. United States v. Glenn-Colusa Irrigation District, 788 F. Supp. 1126 (E.D. Cal. 1992).

Similar decisions have been reached under state endangered species laws. For example, Little Blue Natural Resources Dist. v. Lower Platte North Natural Resources District, 210 Neb. 862, 317 N.W.2d 726 (1982), held that the state Director of Water Resources must comply with the state's endangered species law before issuing a water right for an irrigation project that could harm critical habitat. The project ultimately was abandoned on other grounds. See In re Applications A-15145, 230 Neb. 580, 433 N.W.2d 161 (1988). Reclamation Act amendments (P.L. 102-575, 1992) also are providing increased flows for fish and wildlife in the Central Valley Project.

Of course, federal and state agencies may exercise their discretionary authority under other environmental laws to protect undesignated species and their habitat from the adverse impacts of water diversion projects. For example, in November 1990, following several years of controversy, acting under section 404(c) of the Clean Water Act, the EPA Administrator vetoed an Army Corps of Engineers permit for the construction of the proposed Two Forks Dam in scenic Cheesman Canyon 24 southwest of Denver on the South Platte River. He cited four grounds for his veto: (1) inundation of a prize trout stream; (2) elimination of a major recreation area with a national forest; (3) destruction of valuable but undesignated wildlife; and (4) the availability of less environmentally damaging sources of water supply including leasing or exchanging water with other water rights holders, developing groundwater resources, and installing water saving devices in Denver households. Litigation challenging the veto is pending. An EPA veto of a Virginia water supply project on similar grounds was upheld in James City County v. EPA, 12 F. 3d 1330 (4th Cir. 1993). The Oregon Environmental Quality Commission's rejection (recently upheld by the Oregon Supreme Court) of the City of Klamath Fall's proposed Salt Caves hydroelectric power project on the Klamath River under section 401 of the CWA to protect undesignated trout and their habitat is a similar example. See City of Klamath Falls v. EQC, 318 Or. 532, 870 P. 2d 825 (1994).

### 6.4. CONCLUSION

In acting under most environmental laws, federal and state agencies generally have broad discretion with respect to how much weight to give watershed water quality and cumulative impacts in deciding whether to approve or what conditions to impose on proposed water development projects. For watersheds and river basins in which endangered and threatened species and their habitat have been designated, the ESA generally is a much more powerful legal tool for which implementation of its mandates often will maintain and enhance water quality. Furthermore, its mandates apply broadly to all private, local government, state, and federal actions on private, state, federal, or other public land in the watershed or basin which could injure a designated species or its habitat. In assessing the risk of injury, the cumulative impacts of activities within the watershed or basin must be considered. However, not all watersheds or basins with water quality and cumulative impact problems have designated species or habitat in them. In some of those, for example the Umatilla Basin in northeastern Oregon, anadromous fish runs may have been eliminated prior to the significant strengthening of the ESA by Congress in 1973. For those and other basins and watersheds without designated species or their habitat, other legal and policy paths to improved water quality discussed in this report will have to be utilized.

# 7. THE LEGAL BASIS FOR WATERSHED MANAGEMENT ON FEDERAL LANDS AND FEDERALLY REGULATED WATERS

## 7.1. INTRODUCTION

Federally-owned lands comprise approximately one-third—or about 732 million acres—of the nation's land area (Coggins 1992). Although federal lands are found in all fifty states, the majority lie in the western states, and typically fall within one of the five major federal land "systems": national parks, national forests, national wildlife refuges, wilderness areas, and other, extensive "public land" holdings.

The primary federal agencies responsible for managing these systems are the National Park Service (NPS), the Fish and Wildlife Service (FWS), and the Bureau of Land Management (BLM), all within the Department of the Interior (DOI), and the U.S. Forest Service (USFS), which is located in the Department of Agriculture (USDA). These are but the primary agencies, and various other agencies contribute to the complex regulatory web administering federal lands.

While the federal government holds title in fee to its public lands, the government's stewardship of these lands is tempered by an obligation to manage them with an eye toward the general public interest. In addition, the beds of navigable rivers flowing through federal public lands are owned by the relevant state and are subject to the public trust doctrine discussed above. Congress and the responsible agencies are often faced with the problems of accommodating the various competing—and often conflicting—uses of federal lands. For example, the commodity uses of irrigation, mining, grazing and timber uses often conflict with the various wildlife, preservation, and recreation uses on the federal lands.

Essentially, Congress regulates the federal lands in two ways: through legislation which classifies certain resources as particularly valuable and thus warranting certain additional protections, or through laws which establish specific mandates on how to manage the resources on federal lands. A third avenue exists for administrative, judicial, and citizen oversight of activities on the federal lands in the National Environmental Policy Act. While the overlap of federal statutory and regulatory management of the federal lands is extensive, this section will review the various statutes and directives which fall within these general categories.

## 7.2. WATERSHED MANAGEMENT UNDER EXISTING FEDERAL LAND AND RESOURCE PRESERVATION STATUTES

### *7.2.1. The National Park System*

#### *7.2.1.1. General*

In the early part of the century, Congress recognized the importance of withdrawing certain pristine areas from the inevitable consequences of increased population growth, energy demand, and resource extraction. As a result, Congress enacted the National Park Service Organic Act of 1916, 16 U.S.C. § 1, which charged the National Park Service with preserving the wildlife and scenery of certain congressionally designated park areas for the present and future enjoyment of those amenities (Coggins 1992).

#### *7.2.1.2. Park Service Discretion and Judicial Deference*

Yet while the principal legal mandate for the Park Service was—and continues to be—preservation, the Park Service retains considerable discretion to regulate mining claims, grazing rights, recreation and various other land uses within and adjacent to park lands (ORC 1992). Indeed, the courts have repeatedly upheld the Park Service's discretionary management policies, even if such policies appear to contradict the Organic Act's general preservation directives. For example, the courts have refused to require the Park Service to close a campground to protect grizzly habitat, National Wildlife Federation v. National Park Service, 628 F. Supp. 384 (D. Wyo. 1987), rejected an attempt to close a National Seashore to off-road vehicles, Conservation Foundation v. Hodel, 864 F.2d 954 (1st Cir. 1989), and allowed environmentally damaging road-building in Sequoia National Park, Sierra Club V. Hickel, 433 F.2d 24 (9th Cir. 1970), aff'd on other grounds, 405 U.S. 727 (1972).

In light of traditional principles of administrative law, and recognizing Congress' broad grant of discretion to the Park Service under the Organic Act, the courts' historical deference to Park Service policy judgments is not surprising (ORC 1992). However, as increased urbanization and resource development encroach on park values, the Park Service increasingly will encounter problems from external activities which threaten in-park uses, and the courts may not tolerate Park Service actions which fail to protect parks. For example, in Sierra Club v. Department of the Interior, 398 F. Supp. 284 (N.D. Cal. 1975), a suit was brought to force Park Service action on private logging activities adjacent to Redwood National Park which were causing aesthetic and ecological damage within the park. The Court ruled that the Secretary had abused his discretion by failing to uphold his public trust obligations, and by neglecting to take appropriate steps to curtail the injurious activities. Yet despite the positive implications for watershed protection in Sierra Club, efforts by the federal government and third parties to protect parks from external threats have had mixed success (Coggins 1992), and until Congress acts to expand the Park Service's authority to regulate out-of-park activities, watershed management within the National Park System will remain uncertain.

#### *7.2.1.3. Park Service Management Policies and Guidelines*

As part of its internal management strategy, the Park service relies on a set of mandatory management policies, coupled with various, voluntary resource guidelines (ORC 1992 —citing NPS Management Policies (Dec. 1988)). And although these policies and guidelines address such watershed-related concerns as water quality and quantity, floodplains and wetlands, and federal reserved water rights, the Oregon Rivers Council (ORC) has criticized these directives as "soft constraints on the management of rivers and riparian areas," which "still leave much up to managers' discretion" (ORC 1992).

According to an ORC draft report, a significant number of riverine ecosystems within the National Park System are threatened by grazing, the lasting effects of past placer mining, extensive recreational use, and out-of-park water diversions and impairments which interfere with in-park stream flows. Because the Park Service's policies and guidelines are not, per se, enforceable regulations, ORC recommends that additional federal legislation is needed to restore riparian and other watershed areas degraded by past land use practices, establish enforceable standards aimed at controlling land uses which affect water and watershed quality, require park managers to pursue all available legal means to counter destructive off-park activities, and mandate plan coordination with adjacent federal lands.

### *7.2.2. The Wilderness Act of 1964*

#### *7.2.2.1. General*

The Wilderness Act, 16 U.S.C. §§ 1131-1136, declares that certain areas warrant exceptional protections, and should be maintained in a natural state, unaffected by man's permanent influences. While various factors contribute to the designation of lands under the National Wilderness Preservation System, generally the areas must be large (that is, usually greater than 5,000 acres), roadless, and undeveloped (Coggins 1992).

Currently, the Wilderness System contains over 32 million acres of federal lands (ORC 1992), but that number could exceed 40 million acres when Congress considers recommendations from BLM (ORC 1992).

#### *7.2.2.2. Wilderness Management*

Typically, when lands are transferred into the Wilderness System, the agency which previously had jurisdiction over the lands retains management responsibilities. Once Congress designates an area, many of the traditional land uses which pose threats to watershed quality are prohibited or more strictly regulated. For example, roadbuilding and clearcutting activities are excluded from designated areas, and other uses, such as grazing and recreation, are under tighter regulation. As a result, when BLM or Forest Service lands are transferred into the Wilderness System, the watersheds within them are guaranteed greater protection than if the lands were subject to the agencies' normal multiple-use policies.

Additionally, because wilderness areas may be able to claim certain implied federal reserved water rights, the Wilderness Act could provide an important legal basis for watershed protection. However, the court in Sierra Club v. Yeutter, 911 F.2d 1405 (10th Cir. 1990), vacated on procedural grounds a holding, that wilderness designation creates additional implied water rights. Thus, whether wilderness areas will have continued entitlement to reserved water rights — and their accompanying watershed protections — is left for Congress (Coggins 1991).

### *7.2.3. The Wild and Scenic Rivers Act of 1968*

#### *7.2.3.1. General*

The Wild and Scenic Rivers Act (WSRA) of 1968, 16 U.S.C. §§ 1271-1287, establishes a system to preserve the free-flowing condition of certain riverine segments possessing outstanding scenic, recreational, fish, wildlife, geologic, cultural and other similar values (Gray 1988). To date, 125 river segments have been designated under the program, comprising over 9,000 miles of waterways (ORC 1992). Because the WSRA removes many river segments from the multiple-use mandates of the federal agencies, it offers considerable promise for holistic, watershed-based management approaches to protect water quality and quantity. However, as will be discussed, the WSRA's limited mandates, coupled with its grant of broad discretionary authority to local managers, suggests that further congressional action is needed to provide a truly comprehensive watershed management approach under the WSRA.

### *7.2.3.2. Management of Wild and Scenic Rivers*

Like the Wilderness Act, agency management responsibility of wild and scenic rivers resides with the agency having prior jurisdiction over the resource (Coggins 1992). In cases where other conservation statutes apply, or where agency jurisdictions overlap, interagency coordination is encouraged, and generally, the more restrictive conservation provisions apply.

In carrying out their WSRA management duties, the USFS, BLM and other agencies have broad discretion in establishing specific management directives (ORC 1992). However, the statutory basis for these directives rests on the classification of each segment into one of three sub-classes: "wild river areas," which are free of impoundments, inaccessible by trail and essentially untainted by human imprints; "scenic river areas," which have attributes similar to wild river areas, but which are accessible by trail; and "recreational river areas," is the least restrictive category, and which may be accessible by trail and affected by past development and/or impoundments (16 U.S.C. § 1273). As ORC points out, this classification system may include, but does not require, the management of certain ephemeral streams which are critical to watershed functions.

Importantly, the WSRA instructs federal agencies with jurisdiction over lands adjacent to designated rivers to take whatever actions are necessary to fulfill the general purposes of the act, and the court in Thomas v. Peterson, 589 F. Supp. 1139 (D. Idaho 1984), rev'd on other grounds, 753 F.2d 754 (9th Cir. 1985), held this to be a "continuing obligation" on agencies to protect both water quality and quantity within designated reaches. In support of this ongoing obligation, the court in Wilderness Society v. Tyrell, 701 F. Supp. 1473 (E.D. Cal. 1988), enjoined a Forest Service salvage timber sale on lands beyond the protective corridor established for a designated river segment, partly because the harvest would likely degrade water quality and fish habitat within the designated area. This opinion suggests that federal agencies must comply with recommendations from EPA and state water pollution control boards when taking actions that could affect designated rivers (Arjo 1990).

Additionally, in order to preserve the water quality and free-flowing condition of designated segments, the WSRA restricts the development of any impoundments by the Federal Energy Regulatory Commission (FERC) "on or directly affecting" any designated area, and forbids all agencies from assisting any water development project "that would have a direct and adverse effect on the values for which such river was established." Both of these statutory directives were upheld by the court in Swanson Mining Co. v. FERC, 790 F.2d 96 (D.C. Cir. 1986).

The WSRA adds additional watershed protections to designated segments by expressly reserving unappropriated waters in amounts necessary to fulfill the general purposes of the act. Yet despite the WSRA's apparently restrictive mandates and the caselaw interpreting them, some have argued that the current statutory scheme is overly-discretionary for administering agencies, and ill-suited for effective watershed management.

For example, the Oregon Rivers Council (ORC) notes that "protected areas are limited to "segments" and arbitrarily determined riparian corridors which are not determined by their ecological relationship to the river system" (ORC 1992). ORC also points out that the WSRA provides little authority to prevent adverse impacts arising outside of federal jurisdiction, and fails to confront the problem of restoring degraded rivers. In short, the ORC concludes that the WSRA does not provide adequate legal authority for watershed protection unless an entire river system is designated, and even then, the act can only be considered as part of any integrated watershed management plan.

#### *7.2.4. Watershed Protection Under the Endangered Species Act of 1973*

Since its enactment in 1973, the Endangered Species Act (ESA), 16 U.S.C. §§ 1531-1543, has played an important role in affecting federal, state and private activities on federal lands. Because a primary purpose of the ESA is to preserve the habitats of species listed as threatened or endangered, the act provides a potentially powerful legal mechanism for the protection of watersheds as discussed above in connection with western water law. Recent court actions concerning the Northern Spotted Owl, and the ensuing injunctions of logging activities in the old growth forests of the Pacific Northwest, clearly illustrate the ESA's potential as an effective—albeit backdoor—watershed management directive.

The ESA is a highly procedural statute, and as such, provides substantial opportunity for citizen group involvement. Yet along with the ESA's procedural requirements are a series of rigorous substantive mandates — most notably the protection of "critical habitats" in which listed species reside, which has led Professor Coggins to call the ESA "the closest thing to an absolute management standard in public natural resources law" (Coggins 1992).

### 7.3. WATERSHED PROTECTION UNDER FEDERAL LAND AND RESOURCE MANAGEMENT STATUTES

#### *7.3.1. The Multiple-Use, Sustained Yield Act of 1960*

Ever since Gifford Pinchot espoused the principles of multiple-use and sustained yield during the late nineteenth century, these concepts have been embedded in agency management of the federal lands. However, with the passage of the Multiple-Use, Sustained Yield Act (MUSY) in 1960, 16 U.S.C. § 528 et seq., the watershed resource officially became a "coequal multiple surface use," for which federal agencies were charged with managing for sustained yield.

#### *7.3.2. The National Forest Service*

##### *7.3.2.1. The Organic Act and the USFS's Authority over National Forest Waters*

Watershed protection has been an important if not overriding priority in federal forest management since the late nineteenth century. In the Forest Service Organic Act of 1897, Congress declared that the national forests were "established...to improve and protect the forest within the boundaries [and] for the purposes of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

Yet while the phrase "securing favorable conditions of water flows" has escaped judicial scrutiny, Professor Coggins argues that these words are synonymous with "watershed" (Coggins 1991). Others suggest that Congress was more concerned with protecting watersheds in the National Forests than securing timber supplies (Wilkinson and Anderson 1985). However, in United States v. New Mexico, 438 U.S. 696 (1978), the Supreme Court denied the Forest Service's arguments that minimum instream flows to protect aesthetic, recreational and fish values were reserved to the U.S. within a National Forest. Importantly, the USFS had not argued that it had rights to protect watersheds under the Organic Act, and Justice Powell noted in his dissent that the majority opinion still allowed the USFS to retain certain reserved instream rights for amounts of water needed for timber and "whatever other flora is necessary to maintain the watershed."

Subsequent courts have followed the New Mexico reasoning, and have refused to award the USFS instream rights for wildlife or recreational purposes. However, in United States v. Jesse, 744 P.2d 491 (Colo. 1987), the Colorado Supreme Court accepted the USFS argument that instream flows were essential "to secure favorable conditions of water flows" under the Organic Act, and Professor Coggins suggests that the case stands for the proposition that watershed protection in the form of favorable waterflow conditions implicates not only minimum stream flows but also the physical structure of the stream channel.

#### *7.3.2.2. Forest Unit Planning and Riverine Management Under the National Forest Management Act of 1976*

The National Forest Management Act (NFMA), 16 U.S.C. §§ 1600–1616, provides a comprehensive management scheme for the National Forest System by requiring preparation of management plans for individual national forest units. As of 1988, the USFS had prepared the 10–year management plans required under NFMA for each of the 156 national forest units, and as ORC points out, the implications of these plans for aquatic ecosystems are just now becoming evident (ORC 1992).

NFMA contains several provisions which arguably limit the USFS's discretion in determining allowable land uses and practices within the National Forests. For instance, NFMA directs the USFS to refrain from authorizing logging operations on lands deemed "unsuitable" under applicable forest land use plans. Unsuitability is based on "physical, economic and other pertinent factors," and must be reviewed every ten years (Coggins 1992).

Additionally, NFMA requires that USFS forest plans "insure" that timber harvesting will not result in irreversible damage to watersheds, wetlands, or water quality, and places special restrictions on the use of clear–cutting extraction techniques. As Professor Coggins explains: "the Forest Service not only must conform [timber] sales to [site-specific land use] plans, it must also determine that each sale meets the protective statutory criteria as expanded upon in the regulations," such as state water quality standards. Thus, in Northwest Indian Cemetery Protective Ass'n v. Peterson, 795 F.2d 699 (9th Cir. 1986), rev'd on other grounds, 485 U.S. 439 (1988), the court ruled that the USFS would be in violation of the CWA and

NEPA even if it installed best management practices which complied with the state's land use plan, since its road building activities would still result in violations of the state water quality standards. Although this was a pre-NFMA case, it illustrates how a post-NFMA plan could be struck down if it does not fulfill the disclosure requirements of NEPA, or if it violates a state water quality standard.

Although few courts have dealt with the adequacy of NFMA-mandated forest plans due to the long processes of plan preparation and administrative review, the court in Citizens for Environmental Quality v. United States, 731 F. Supp. 970 (D. Colo. 1989), enjoined the USFS from increasing timber harvest levels in the Rio Grande National Forest in Colorado, partly because USFS failed to abide by the water quality and riparian protections of NFMA.

Yet despite Citizens' potential to bolster NFMA's watershed protections, the USFS's implementing regulations and other guidance provide only general management directives for safeguarding riparian areas, and offer little to determine adverse effects on riverine systems (ORC 1992; 36 C.F.R. 219 et seq.) For example, the regulations vaguely state that "special attention shall be given to land and vegetation for approximately 100 feet from the edges of all perennial streams" (36 C.F.R. 219.27(e)). Additionally, the regulations appear to allow certain adverse effects on fish as long as "minimum viable" populations are preserved, which suggests that considerable population decline will be tolerated until this minimum threshold is attained (Anderson 1987). Other similarly vague or misreasoned directives are scattered throughout the NFMA regulations and guidance (ORC 1992).

### *7.3.3. The Bureau of Land Management (BLM)*

#### *7.3.3.1. The Federal Land Policy and Management Act of 1976*

The Federal Land Policy and Management Act (FLPMA), 43 U.S.C. §§ 1701-1784, governs BLM's administration of grazing, mining, logging, off-road vehicle and other uses on the federal lands. Although a primary purpose of FLPMA was to inject more formal, systematic land use planning into BLM's management plans, FLPMA has been criticized for being substantively vague, and BLM has yet to fulfill the statute's mandate to establish plans for all BLM lands (ORC 1992).

Many of the statutes governing land management under the BLM generally are less specific than those governing the USFS (ORC 1992), and over the years, BLM's land management policies have prompted criticism from environmentalists. However, in Natural Resources Defense Council v. Morton, 388 F. Supp. 829 (D.D.C. 1974), the Court rejected BLM's argument that a programmatic EIS would suffice to assess environmental impacts on all BLM grazing programs, and instead required the agency to prepare numerous district-specific EISs. As a result of the NRDC decision, BLM's subsequent decisionmaking processes have undergone unprecedented degrees of public scrutiny (ORC 1992).

#### *7.3.3.2. BLM Section 1712 Planning*

Although a primary purpose of FLPMA is to guide BLM in its stewardship of the public lands, many have criticized its lack of substance, schedules and content (Anderson 1987). Section 1712(c) sets out nine criteria which the Secretary of the Interior must consider when setting land use plans and development agendas, and although each appears be a mandatory congressional charge, Professor Coggins has labeled them "remarkable for their lack of specificity" (Coggins 1992).

Roughly, those criteria which appear to be required in section 1712 plans and which relate to watershed and water quality protection are priority consideration for areas of critical environmental concern (ACEC), compliance with applicable state and federal pollution laws, and undertaking any necessary actions to prevent undue degradation of public lands. In addition to these are a host of more general requirements such as consideration of existing and future uses, using multiple-use/sustained yield principles, weighing long-versus short-term benefits, and consideration of the "relative scarcity of values."

Although FLPMA apparently intends that section 1712 land use plans be binding upon BLM, and despite FLPMA's procedural directives mandating public involvement, BLM retains considerable discretion in setting its land use priorities, methods and topics (Coggins 1992). Numerous courts have deferred to BLM's judgment when reviewing section 1712 plan adequacy (ORC 1992).

#### *7.3.3.3. Implementation of Watershed and Riparian Protection Measures*

Despite Congress' apparent recognition in FLPMA that riparian and riverine areas within BLM range and forest lands were in need of serious attention, BLM's policies and implementing regulations do not accurately reflect this congressional concern. For example, ORC has characterized the FLPMA regulations pertaining to fish and wildlife, and watersheds as "too vague," and "not pos[ing]...real management constraint[s]" (ORC 1992).

ORC also points out that both FLPMA and the Public Rangelands Improvement Act of 1978 (which establishes national grazing policies for the USFS and the BLM) provide sufficient authority for BLM to protect aquatic systems from the impacts of grazing, but since neither statute mandates the protection of these areas, BLM has been slow to implement such programs (ORC 1992). Additionally, BLM has plainly sacrificed various watershed values for the benefit of certain commodity extraction values (for example, timber, grazing) (ORC 1992; Coggins 1991) — apparently in contradiction to the multiple use/sustained yield mandates of FLPMA, yet the courts have yet to overrule BLM's discretionary management policies even when one resource has been damaged by the overuse of another.

Furthermore, ORC has criticized BLM's national riparian and wetland policies as too "general," and lacking "any concrete management guidelines" (ORC 1992). ORC also notes that BLM may have some legitimate obstacles in its path toward watershed management — for example, lack of resources to enforce plans and permits, dependence on cooperation from grazing/logging permittees, and inability to control up-stream uses of non-federal land.

### *7.3.4. Water Impoundments Under the Federal Energy Regulatory Commission*

#### *7.3.4.1. Background*

Dam and impoundment planning and building falls under the jurisdiction of a myriad of state and federal authorities, including the Federal Energy Regulatory Agency (FERC), the Army Corps of Engineers (COE), the Bureau of Reclamation (BOR), the Soil Conservation Service and state water resource agencies. Due to the independent historical development of each of these groups, coupled with their often divergent purposes, dam and impoundment planning has escaped any semblance of a comprehensive, river basin type approach.

The impacts of hydropower facilities on watershed values are manyfold. Hydropower facilities disrupt the natural flow regimes of rivers and streams, disturb the migration patterns of anadromous fish, and affect water quality by concentrating sediment and contaminants behind dams, among other things. Yet at the same time, hydropower is often looked upon as a "clean" power source, particularly as the U.S. seeks to end its dependence on foreign oil supplies, and the burning of fossil fuels is frowned upon in the global warming debate. As a result, although the damming of riverine systems is coming under increased environmental scrutiny, hydropower development continues to find support, particularly when compared to the development of nuclear, coal and oil energy generation.

*7.3.4.2. The Federal Power Act*

The Federal Power Act, 16 U.S.C. §§ 791–825, as amended by the Electric Consumers Protection Act in 1986, allows FERC to license hydroelectric projects on federal lands and within waters subject to Congress" commerce clause authority (for example, on navigable waters). As a result of what many considered a proliferation of hydropower development at the expense of environmental values under the original FPA, the 1986 amendments mandated equal treatment for both power and environmental interests. Specifically, FPA section 4(e) now requires FERC, in addition to considering power and development purposes during licensing proceedings, to give equal consideration to the purposes of energy conservation, fish and wildlife protection, the protection of recreational opportunities, and the preservation of other environmental aspects (16 U.S.C. § 797(e)). See Platte River Whooping Crane Critical Habitat Maintenance Trust v. FERC, 962 F.2d 27 (D.C. Cir. 1992).

Additionally, section 4(e) requires that these determinations be "desirable and justified in the public interest," and the courts generally have held that FERC must make such determinations prior to the issuance of a license. See, for example, Federal Power Commission v. Oregon, 349 U.S. 435 (1955). Importantly, FERC's licensing procedures are subject to the mandates of NEPA, and environmental impact statements may be required if a license issuance might "significantly affect the quality of the human environment." See, for example, National Wildlife Federation v. FERC, 912 F.2d 1471 (D.C. Cir. 1990).

Section 10(a) is the FPA's planning section. It requires that all licenses issued by FERC be in accordance with a "comprehensive plan for improving or developing a waterway...[for] commerce, for the improvement and utilization of water power development, for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial public uses..." 16 U.S.C. § 803(a). As ORC notes, FERC has taken the position that section 10(a)'s comprehensive planning requirements do not require it to complete systematic plans for entire river basins, but instead need only consider the facts presented during licensing proceedings (ORC 1992). Several court decisions have contradicted this position by holding that FERC must consider a project's impacts on all other projects within a river basin when adopting comprehensive plans. For example, LaFlamme v. FERC, 852 F.2d 389 (9th Cir. 1988).

Additionally, under section 10(j), FERC must impose conditions on licenses based on recommendations received from the National Marine Fisheries Service, the Fish and Wildlife Service and state fish and wildlife agencies. 16 U.S.C. § 803(j). However, the authority of state agencies to influence FERC license applications has been cast into question as a result of the Supreme Court's ruling in California v. FERC, 110 S.Ct. 2024 (1990), which allowed FERC to preempt the instream flow recommendations made by California to protect fishery and recreational values. A potential foothold for states, however, may be found in section 401 of the Clean Water Act, which recently has been held to require FERC to obtain certification from the state that the anticipated project will comply with state water quality standards. Keating V. FERC, 927 F.2d 616 (9th Cir. 1991). The United States Supreme Court recently approved state minimum stream flow requirements imposed on a hydroelectric project subject to FERC's jurisdiction through a section 401 certification. State v. PUD No. 1, 121 Wash. 2d 179, 849 P.2d 646 (1993), affirmed, 1994 WestLaw 223 821 (May 31, 1994). The Oregon Supreme Court recently approved a similar use of the 401 certification process. City of Klamath Falls v. EQC, 318 Or. 532, 870 P.2d 825 (1994).

As the cases involving FERC suggest, FERC has considerable discretion in carrying out section 4(e)'s public interest review, and section 10(a)'s comprehensive plan requirements. Possibly as a result of its history as a power development agency — rather than an environmental protection agency—FERC has been criticized for its disregard for environmental values (ORC 1992). In fact, according to ORC, FERC has denied only one license application on environmental grounds.

## 8. SUMMARY

This report has reviewed federal, state, and local laws, policies, and programs relevant to watershed management and cumulative impact assessment. Within the current legal and institutional framework, watershed approaches generally are possible but not required. Adequate discretionary authority exists for improving watershed water quality in three major areas: reducing water diversions out of watersheds, reducing watershed pollutant loadings, and other watershed habitat improvements. Further research appears to be needed on the relative significance to improved watershed water quality of progress in each of those three areas.

The new federal Coastal Zone Management Act coastal non-point source pollution control requirements provide perhaps the firmest legal foundation for integrated federal, state, and local approaches to coastal water quality problems. Proposed Clean Water Act NPS amendments based on them would firm up the legal framework controlling non-coastal NPS pollution as well. Both the CZMA and CWA NPS provisions apply to NPS pollution sources located on federal public lands.

Federal public lands management law generally requires the designated federal land management agency to consider watershed values from a multiple-use perspective. Within that framework, the agencies have considerable discretion to implement integrated management approaches which protect watershed water quality, including programs coordinated with private and public landowners upstream and downstream from the federal watershed lands.

Stronger mandates to protect watershed water quality apply when federal resource protection laws such as the Endangered Species Act and Wild and Scenic Rivers Act become applicable to federal, private, and other public lands in a particular watershed or river basin. Aggressive federal agency assertion of reserved water rights for federal land could yield increased flows benefiting watershed water quality. In any case, activities conducted on federal lands should comply with applicable state water quality standards.

ESA designations of endangered or threatened fish and their habitat can lead to major changes in watershed water use by federal, state, local, and private water users. Such changes (ordered by the courts where necessary) frequently benefit watershed water quality and habitat. Outside river basins and watersheds with ESA designated species, state water law controlling water diversions is changing through judicial, legislative, and regulatory actions giving greater weight to instream water uses and habitat values. Thus these trends generally support implementation of an integrated watershed approach. Diversions of water for irrigated agriculture in particular are coming under increasing scrutiny and voluntary and involuntary reallocations to instream purposes are occurring. (National Research Council 1992).

However, the legal framework addressing agriculture's addition of pollutants to watershed waterways remains incomplete. Irrigation return flows are exempted from the Clean Water Act's elaborate point source discharge permit system. Thus their control depends on state CWA NPS and coastal NPS programs, the largely voluntary and somewhat fragmented federal, state, and local soil conservation programs, or special state agricultural pollution control programs like Idaho's.

The important roles such state legislation could play are illustrated in Oregon by the state's Forest Practices Act under which the adverse impacts on watershed water quality of forestry activities on state and private forest lands are being subjected to increasing control. The Oregon legislature has passed SB 1010, which gives the state Department of Agriculture some control over non-point pollution from agricultural activities. Water districts serving irrigated agriculture could play key roles in implementing any agricultural practices legislation that is enacted (Davidson 1989; Foran 1991).

Along with agricultural practices legislation, the Oregon legislature through its committee structure should consider the following issues raised by Oregon's watershed water quality management experiences to date: the roles of local comprehensive land use plans developed under the state's land use planning law and new special area management plans designed with water quality as a major goal in protecting watershed water quality; the connections between watershed water quality and safe drinking water supplies and shellfish sanitation; effective implementation of the state's instream water rights programs; and strengthening the state's scenic waterways program with respect to riparian buffer zones.

The foregoing recommendations are meant to support, not preclude, voluntary and incentive-based efforts to control watershed pollution currently being implemented or considered. Improved planning and regulatory capabilities can be viewed as necessary preconditions for successful implementation of tradable pollution rights programs (Lence 1991; Willey 1992) and voluntary changes in land use practices and other activities that cumulatively and adversely affect watershed water quality. Furthermore, stringent regulation of private land to protect watershed water quality and avoid adverse cumulative impacts raises unique policy, constitutional, and other legal questions as the U.S. Supreme Court's recent decision in Lucas v. South Carolina Coastal Council, 112 S. Ct. 2886 (1992) illustrates. The case involved a claim for compensation by a coastal landowner whose property uses had been significantly curtailed by a state law designed to protect coastal resources from adverse land use impacts. The water quality impacts of watershed land uses have only recently been identified as externalities potentially subject to regulatory control; the political will and the legal authority to apply regulatory solutions have evolved only very slowly. Also, current federal and state fiscal constraints limit the amount of resources available for staffing new regulatory initiatives designed to protect and improve watershed water quality.

All these factors suggest that wherever possible integrated watershed management be carried out based on existing laws and institutional arrangements (Weatherford 1990), including ones like EPA's Watershed Protection Approach, Oregon's Strategic Water Management Group, Governor's Watershed Enhancement Board, and national estuary program designation for Tillamook Bay, Oregon and Washington's Lower Columbia River Bi-state Water Quality Program, Idaho's Agricultural Pollution Abatement Program, North Carolina's basin-wide approach, and Washington's shellfish protection legislation, and locally innovative ones like the Coquille River water quality project and the proposed Integrated McKenzie Watershed Program in Oregon.

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